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PRACTICAL SURGERY

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OUTLINES

OF

PRACTICAL SURGERY.

BY

WALTER G. SPENCER, M.B., M.S., F.R.C.S.,

SURGEON TO THE WESTMINSTER HOSPITAL.

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PREFACE

As the title indicates, this book on Surgery is limited to Practical Subjects. Details of Pathology and Bacteriology are best dealt with in special works. The same remark applies also to Ophthalmic Surgery.

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OUTLINES OF PRACTICAL SURGERY

PART I.

GENERAL METHODS.

CHAPTER I.

THE TREATMENT OF WOUNDS.

Healing of a Wound.

WOUNDS heal by a natural process similar to that by which the various tissues in the embryo develop. But the reproduction is confined to certain tissues only. Fibrous tissue and epithelium form again, but not elastic tissue, muscle, glands, nor the other more highly organized structures. The process of healing is interfered with in a variety of ways, which can in the main be referred to one cause, viz., inflammation due to small organisms. A great revolution has taken place in the art of surgery owing to the introduction of antiseptic measures by Lister. These measures were, and are, primarily based upon practical experience, which has proved that inflammation in wounds can be prevented; but they continue to gain support from experiments as to the life-history of the organisms which originate inflammation, and as to the resistance presented by the various tissues to the attack of these parasites. The most important principle of surgery, therefore, is the protection of a wound from infection, and the destruction or weakening of the activity of parasitic organisms already in the wound. Wounds are protected from infection by methodical cleanliness; organisms are destroyed or weakened by antiseptics—chemical substances which do not importantly damage the cells and tissues of the body.

Antiseptics.

Very many chemical substances have whilst in solution or in powder the power of destroying the activity of micro-organisms without injuring the tissue. The best known and most widely used are:

Carbolic Acid.—Carbolic acid was the earliest, and has been the most widely-used, antiseptic. It is still the most satisfactory one, both from a practical and an experimental standpoint. Only the purest crystals should be used for wounds. The crystals are just moistened so as to make a syrup, and 1 part is then added to 19 parts of hot water so as to make the stock solution, containing 5 per cent. carbolic acid. The undiluted syrup made by just dissolving the crystals in water or glycerine is painted on phagedenic or diphtheritic wounds, and is applied to the walls of small tubercular abscesses. A film of coagulated albumin is formed, and every organism within reach is instantly destroyed, so that all the carbolic acid can be at once washed away. The tissues are not penetrated deeper than the diseased surface, nor are healthy tissues injured, and, owing to the analgesic properties of the undiluted solution, no pain is occasioned. Owing to the latter action, a bit of wool can be squeezed out of the syrup and put into a hollow aching tooth, or a drop may be put on the apex of a pustule or boil before puncturing it.

Five per cent. carbolic acid is used for the skin, for instruments, ligatures, and sponges, and for infected wounds. In the latter case it must be washed off again with water. Contact for half a minute weakens or kills all the parasites.

2·5 per cent. carbolic acid may be used for washing the hands, sponges, etc., during an operation, and for healthy ulcers.

Poisonous Action.—Carbolic acid must not be freely applied to any mucous or serous surface, such as the mouth, rectum, bladder, conjunctiva, knee-joint, or peritoneum, nor be injected into any large abscess cavity. It should not be applied to the skin, especially in children, for longer than an hour, or two at the most in the case of thick adult skin, for fear of absorption. It is therefore not employed for fomentations; besides, superficial bloodvessels become contracted, and gangrene of fingers has been caused even when only a weak solution has been used.

Mercuric Chloride (‘**Perchloride**’ or ‘**Sublimate**’).—The corresponding iodide may be substituted.

0·5 per cent. (2 in 1,000) may be used like the pure carbolic acid, but has not the same analgesic properties.

Mercuric chloride 0·1 per cent. (1 in 1,000) corresponds in use to 5 per cent. carbolic acid, and 1 in 2,000 with the 2·5 per cent. It may be used for the skin of the surgeon's hands, especially where carbolic acid is likely to produce an eczema and fibrillation of the nails. It must not be kept in contact with the patient's skin, or a pustular eruption will arise in many cases, and although the pustules may not contain organisms, yet the healing of the wound will be disturbed. It should not be used for instruments—the mercury is deposited and the solution thereby weakened; instruments lose their polish and knives their edge.

The solutions are a deadly poison, and must be taken special care of on account of the absence of colour and odour. Likewise it will decompose on standing, especially in light or in contact with organic matter.

Mercuric chloride acts powerfully on organisms grown artificially, but its compound with albumin is comparatively inert. Therefore there is great doubt whether it is so powerful an antiseptic in a wound as carbolic acid, which, although it also precipitates the albumins, loses none of its activity thereby.

Poisonous Action.—All the mercuric chloride must be washed out of the wound by plain water, and it should never be injected into any cavity, natural or artificial, nor be applied to a mucous or serous surface except in some very limited way, and in such weak solutions as 1 in 10,000.

Potassium Permanganate, Liquor Potassii Permanganatis, B.P., is a 1 per cent. solution. Condy's Fluid is a 2 per cent. solution. Owing to its oxidizing property, it acts as a deodorant and antiseptic without causing any irritation. Any change in colour of the solution marks the loss of its oxidizing property. A 1 per cent. solution may be mixed with equal parts of warm water and used for irrigating mucous or abscess cavities and ulcers, or for baths, *e.g.*, for the arm, leg, or genitals.

Boric Acid.—As a powder it may be freely dusted on any healing wound or ulcer wherever the discharges are small in amount, or, placed between layers of gauze, it adds to the antiseptic properties of a dressing. It is unsuitable for use to a mucous surface, on account of its solubility.

A hot saturated solution is used for fomentation by dipping lint into it, and this fomentation has quite supplanted the poultice wherever the skin is broken.

It is also employed to irrigate wounds and cavities, but is not so active as the permanganate; indeed, it has no advantage over water for this purpose.

Iodoform.—It is used either as crystals or in powder. It has two important properties: its relative insolubility and its powerful odour. In addition it is an anæsthetic, and therefore does not irritate, but, on the contrary, allays pain. Its value is most strongly confirmed by practical experience, for it undergoes solution slowly yet continuously when in serous or mucous fluids, and thus hinders the growth of parasites, especially the tubercle bacillus, whilst allowing the cells to grow freely.

Applied to a wound otherwise bathed in mucus or pus, especially when backed by absorbent gauze, suppuration is prevented, the discharge becomes small in amount and serous, and the wound beneath the covering of iodoform heals rapidly by granulation.

It should not be applied, however, to any large surface when the lymphatics leading from it are unobstructed, such as a clean-cut wound or a healthy synovial membrane.

Iodoform may be rammed into small tubercular cavities of bone. As a 10 per cent. emulsion in glycerin it may be injected into large abscess cavities, especially those due to tubercle, such as a psoas abscess, the excess in all cases being squeezed out again. For such a purpose the emulsion must be freshly made to avoid free iodine. It should not be used, however, where albuminuria is already present.

The largest picked crystals are required for covering the stump after removal of the tongue.

A saturated solution of the powder in equal parts of absolute alcohol or ether may be sprayed upon small wounds and ulcers of mucous membranes, *e.g.*, tubercular ulcers of the larynx; the part is thus uniformly covered by a fine layer of iodoform.

Iodoform is used as a deodorant in gangrenous affections, but, in addition, sloughs must be removed or the extension of the process arrested by some strong antiseptic or caustic, for the action of the iodoform does not penetrate.

The Cleansing of the Hands and of the Skin of the Patient.

It is most essential that the hands of both surgeons and nurses should always be clean. No one ought ever to touch a wound without having first washed the hands. All engaged in surgical work must make this a systematic practice. The hands and forearms are brushed with soap and water, and are finally swilled in clean water, or in carbolic acid or sublimate solution. The nails should be kept short: long nails ill become a handworker; however carefully attended to, they must necessarily retain some dirt. Fingers which have come in contact with septic material should be rubbed well with gauze soaked in 5 per cent. carbolic acid or 1 in 1,000 sublimate. Turpentine similarly used removes the smell remaining after digital examinations.

The most virulently infectious matter is derived from ulceration and necrosis of bone, purulent peritonitis, erysipelas, scarlet fever, and puerperal fever. All chance contamination from such cases must be carefully guarded against. Perhaps the wound most sensitive to septic infection is that left on the separation of the placenta. The mortality from puerperal fever in private practice has not yet greatly diminished, whilst in lying-in hospitals it has been practically abolished. A part, at any rate, of this mortality must be attributed to infection transmitted by the hands of practitioners and midwives.

Previous to the operation the patient should, if possible, have a hot bath with abundant use of soap, and then put on clean linen. About two hours before, the part for operation must be well washed, shaved of hair, sweat and epidermal débris removed by scraping and by the aid of turpentine or ether, and then covered with lint wrung out of 5 per cent. carbolic acid. Carbolic acid macerates the superficial layers of the epidermis, and penetrates into the folds. It should not be applied in this way to the face, and particularly not to the eyelids. One hour is quite sufficient for the thin skin of a child. If applied for more than two hours, absorption may occur, even through the unbroken skin.

The Cleansing of Instruments and Sponges.

Instruments required for the operation are to be placed in a tray and covered by 5 per cent. carbolic acid for ten minutes before use. When the operation is on a mucous or serous surface the carbolic solution should be poured off and the instruments laid on a towel or in water. This may also be done if carbolic acid affects the surgeon's hands, otherwise the instruments should be returned to the carbolic acid tray as often as possible during an operation. Cataract knives must not be put into carbolic acid, or the edge will be blunted ; they are dipped into absolute alcohol.

After use instruments should be washed and scrubbed in boiling water, placed on the tray of a vessel similar to a fish-kettle, and boiled for half an hour in a 3 per cent. solution of sodium bicarbonate, then dried with a hot towel and the steel polished with leather. Instead of the carbolic acid tray the instruments may be boiled before the operation, or put into a wire basket and exposed to superheated steam in a sterilizer. But this method is not so generally applicable except in an operating theatre. Even there the liability to infection after the sterilization, the blunting of the edges of the knives, the sudden need of some instrument which has not been prepared, and the necessity for duplicate instruments where one operation follows another, all point to the fact that the carbolic acid tray is more generally applicable than any sterilization process.

Hollow metal instruments require special care, and must be well syringed through with hot water. Rubber catheters and drainage-tubes can only be kept free from infection by lying in 5 per cent. carbolic acid. Antiseptic vaseline is rubbed over saws and other large surfaces of steel to prevent rust.

Sponges.—Marine sponges when purchased contain sand and the remains of organisms. Whilst dry they should be put into a bag and beaten, then steeped and repeatedly kneaded in warm water for several days until no more grit can be got out. They are then bleached by steeping in 20 per cent. sulphurous acid for twelve hours, preceded or not by dipping in 0·6 per cent. potassium permanganate for ten minutes. They are then kept dry until wanted. During an operation sponges are washed in 2·5 per cent. carbolic acid, 1 in 2,000 sublimate, or in water which has been boiled. The one objection to their general use is the difficulty of getting the blood-clot out again from their pores. After an operation sponges must soak in warm water, with frequent kneading, for as long even as twenty-four hours, until the water is no longer stained. They are then put into 5 per cent. carbolic acid for at least a day before being used again. Sponges used for the skin, for the mouth, for healthy urine or fæces, for inodorous pus, or which fall on the floor, must not be used again until after cleansing. Sponges coming in contact with foul pus, gangrenous or erysipelatous wounds, must be burnt.

Pledgets of cotton-wool wrung out of 5 per cent. carbolic acid are useful as wipers in all septic cases. The wool is expanded by heating before a fire, and is then tied up in a layer of gauze; these may be sterilized by steam. Antiseptic or sterilized gauzes may also be used as sponges.

Sponges should be well squeezed out before being handed to the surgeon.

In using, the sponge should be pressed firmly on the surface without rubbing, unless it be desired to discover the position of a vessel by making it bleed, or when it is necessary to wipe away pus or blood-clot.

Sponge-holders are required for use in the mouth, pharynx, abdomen, etc.

When inserted into cavities, such as the peritoneum, the number of sponges used should be counted before the operation, and again before the closure of the wound. It is always wise to have a piece of silk tied tightly round the smaller sponges, the free end of which hangs out of the wound.

The Washing of Wounds and Cavities.

Water is now generally used alone. Good drinking-water boiled for half an hour is free from pathogenic organisms. Clean rain-water, or sea-water, or distilled water may be employed. With respect to the latter, it must be remembered that commercial distilled water is condensed engine steam, liable to all kinds of contamination. A pressure-filter may be attached to a hot-water tap, and if the porous cylinders through which the water is driven be boiled every day or so in soda solution a satisfactory water is the result. Standing water and filters which cannot be cleaned are to be avoided.

Infected wounds may be washed with 2·5 per cent. carbolic acid, or 1 in 2,000 sublimate, but all the antiseptic should be finally swilled away with water. Constant irrigation during an operation is unnecessary and tiresome; a thorough washing before suturing is quite enough. Continuous irrigation is occasionally of service in large infected wounds. A trough is placed under the part, and a stream from above so arranged as to drop into the wound continuously. The can is fixed over the patient; it should be covered to prevent loss of heat, and requires frequent filling. If any antiseptic be used, it should be a weak solution of potassium permanganate or boric acid.

Arm and leg baths, and occasionally baths for the whole body after extensive burns, multiple abscesses, etc., must have the water frequently renewed. Permanganate or boric acid may be mixed with it.

Prevention and Arrest of Hæmorrhage.

Hæmorrhage during an operation is reduced to a minimun by so planning the operation that the large vessels are exposed first of all, and clamped or ligatured. The smaller arteries and veins can often be seized before division, or immediately after, by clamp forceps.

A surgeon cuts quickly through superficial structures, but when he approaches a large vessel he proceeds warily, to avoid an accidental puncture. If the operation be on one of the limbs, a tourniquet, consisting of stout rubber tubing, is made to take several turns tightly round the limb. The rubber bandage is now discarded, as diseased material might easily be squeezed onwards into healthy tissue. The limb is simply elevated to the vertical, and stroked towards the trunk. The tubing should only be applied to a fleshy part of the limb, not where nerves would be compressed against bone, or paralysis may follow. The small veins and arteries are apt to bleed freely when the band is relaxed, therefore it should not be taken off when only small vessels have been cut through—*e.g.*, in operations on the knee—until the limb has been firmly bandaged. If the band has been removed, in order to see whether all large vessels have been tied, the oozing from small ones may be stopped by reapplying the band until after bandaging.

The larger vessels, which have been seized with clamp forceps, are ligatured or twisted, the smaller ones being closed by the pinching of the forceps in a few minutes. Twisting the clamp forceps until they come away will arrest bloodvessels in muscle ; but it is not so good for vessels in unyielding aponeuroses, nor in friable tissue. When the bleeding-point can be controlled by clamped forceps, but a ligature cannot be applied, the forceps are left hanging out of the wound, and are removed the next day.

Occasionally the tenaculum, or sharp hook, is used to transfix a vessel which the forceps cannot catch, and the ligature is then tied over the hook, or the mouth of such a vessel can be transfixed by a needle carrying the ligature.

The oozing from small vessels is checked by the drying action of the air promoting coagulation, and the clot ought not to be disturbed by sponging.

Firm pressure with a hot sponge for one to five minutes also favours arrest. And further pressure is exercised by deep sutures and firm bandaging.

Hot water, applied at a temperature of 130° F. or 55° C., is the only hæmostatic used for wounds. At this temperature it causes contraction of the capillaries; when hotter still, albumin is coagulated.

Bleeding from a divided bone is stopped by pressure, or by rubbing in antiseptic wax (carbolic acid crystals, 5 parts; wax and paraffin, āā 95 parts, heated to boiling). When bleeding from small vessels cannot be stopped, or when a recurrence of oozing is anticipated, the wound is plugged firmly with strips of iodoform gauze. The ends are brought out at the angle of the wound, the rest of which is sutured. Sometimes the sutures are simply passed, but not drawn tight until the next day, when the gauze is removed and the wound closed (secondary suture).

The actual cautery is not now employed as a hæmostatic, unless under exceptional circumstances, to arrest oozing from a surface upon which firm pressure cannot be applied, nor the bleeding arrested by a ligature or by suturing the surface. If used, the surface must be just seared and dried, not charred, or a slough will form, and secondary hæmorrhage or suppuration result.

Ligatures.

Silk is the most serviceable ligature from all points of view. The smaller sizes tightly spun are called 'Chinese twist.' In large sizes, 'floss silk,' or three-corded silk, also called 'dental silk,' because used for drawing between the teeth, the twist is less close. Silk has this great advantage, that without any special preparation a clean skein is free from septic germs. A skein is wound on a perforated glass or wooden bobbin, and is placed in 5 per cent. carbolic acid in a wide-mouthed glass-stoppered bottle for a day beforehand. The free end being caught with forceps, lengths may be cut and dropped into a bowl containing carbolic acid without exposing the bobbin. There is no need to boil the silk. This has been done during the manufacture, and if carelessly repeated may render the silk brittle. Silk is, of course, an animal substance, and is attacked and removed by the digestive action of the leukocytes and serum. This process varies in rate. It is very rapid in the peritoneal cavity, but in other tissues takes between one and three months, according to the size of the ligature. Occasionally a ligature may remain in as long as a year unaltered, or be discharged along a sinus. In the latter case the wound has been affected by inflammatory complications, which impair the digestive properties of the tissues.

With aseptic silk, and the ligatures and knots no larger than necessary, such complications become very rare.

Catgut is prepared by macerating and then twisting the intestines of sheep. It is a process carried on chiefly in Spain, uncontrolled by scientific knowledge, so that dried commercial catgut has septic germs rolled up in it. The great problem is, therefore, how with certainty to render it antiseptic without destroying its characteristic toughness and pliability. There are many methods, but no one absolutely reliable. The brown catgut is almost entirely absorbed in a week, which is too rapid for hernia operations and for those on large vessels.

Chromicized catgut, if kept dry, will bear steeping in carbolic acid for some time; then, it is much less readily absorbed—indeed, no more readily than silk.

Unfortunately, a sample of catgut is occasionally met with which starts severe septic suppuration of a dangerous, or even fatal, kind, and this is the reason why many surgeons never use it.

Kangaroo-tail Tendon.—The tendons are drawn out from the tail of the kangaroo and dried. They form flat ligatures 1 to 4 mm. broad, which if placed in 5 per cent. carbolic acid solution for a day or two before use are excellent for tying the large arteries in continuity. Being flat, they would slip if placed upon the cut end of a large artery, unless the artery be tied like a pedicle by transfixing it. Their cost prevents any large use of kangaroo-tail tendon. They are suitable for varicocele or for hernial rings, but cannot be tightened sufficiently for an omental or ovarian pedicle.

Flat ligatures of a similar kind for ligaturing large vessels in continuity are made from the parietal peritoneum of the ox—'goldbeater's skin.'

Application of the Ligature.

Simple Knot (Fig. 1).—Small vessels are tied by the double knot, the forceps being generally taken off whilst the first loop is strained tight, unless there is plenty of room between the ligature and the forceps.

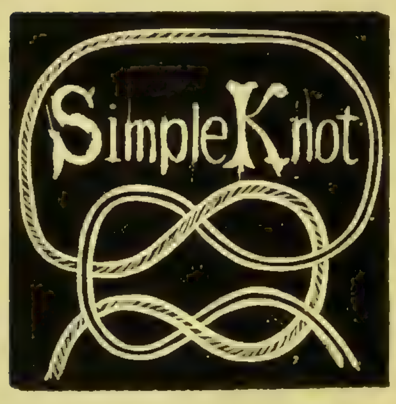

FIG. 1.—SIMPLE KNOT.

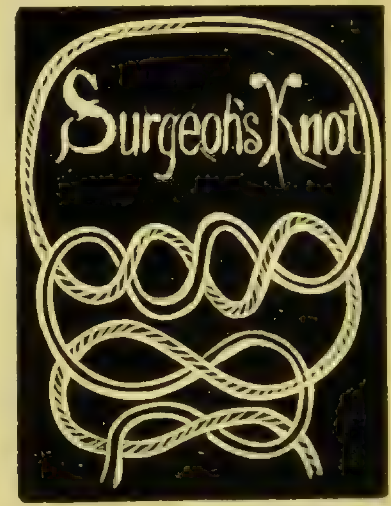

FIG. 2.—SURGEON'S KNOT.

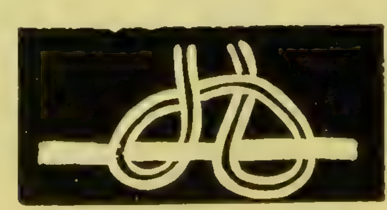

FIG. 3.—CLOVE HITCH.

Surgeon's Knot (Fig. 2).—A second turn is made in the first loop, so that when once drawn tight no yielding takes place whilst the second loop is being tied. A third loop is drawn tightly over the second. This is the knot used for tying large arteries and pedicles.

A **Clove Hitch** is formed as in Fig. 3.

Interlocking Ligatures for Pedicles (Figs. 4, 5, 6, 7).—When much tissue is included in a ligature some shrinkage from pressure takes place, and so a simple circular ligature becomes loose and slips off. Structures such

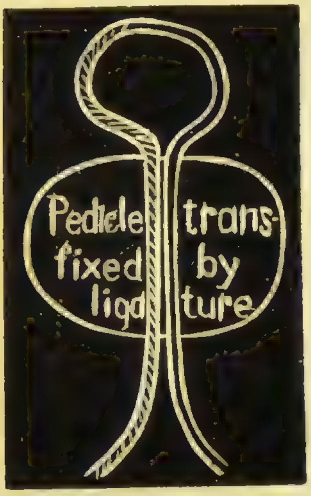

FIG. 4.—PEDICLE TRANSFIXED BY LIGATURE.

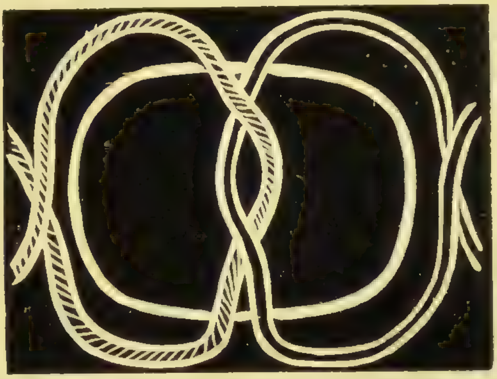

FIG. 5.—PEDICLE LIGATURE DIVIDED: HALVES INTERLOCKED.

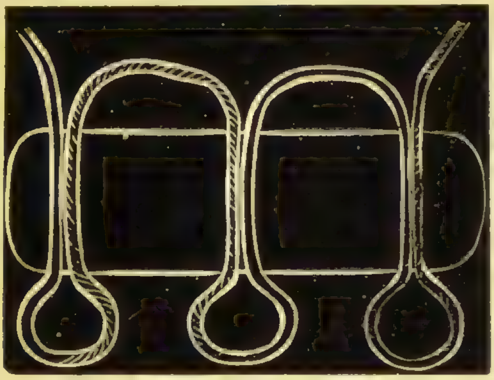

FIG. 6.—BROAD PEDICLE TRANSFIXED.

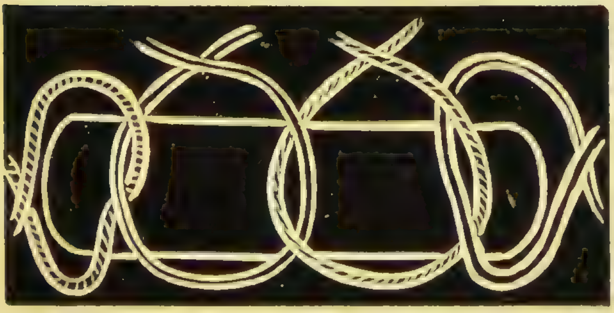

FIG. 7. LIGATURES DIVIDED AND INTERLOCKED FOR A BROAD PEDICLE.

as the spermatic cord, omentum, or the pedicle of an ovarian cyst, must be perforated by a needle on a handle carrying a long ligature, with the ends of equal length, and the middle of the ligature is held whilst the needle is withdrawn and unthreaded. The ligature is then divided, the two halves made to interlock, so that when each half is tied by a surgeon's knot on its corresponding side the pedicle is not split, nor any vessel torn open.

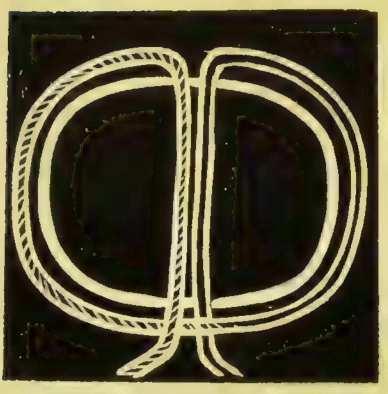

FIG. 8.—PEDICLE TRANSFIXED: LOOP OF LIGATURE BROUGHT OVER, PARTLY FORMING STAFFORDSHIRE KNOT.

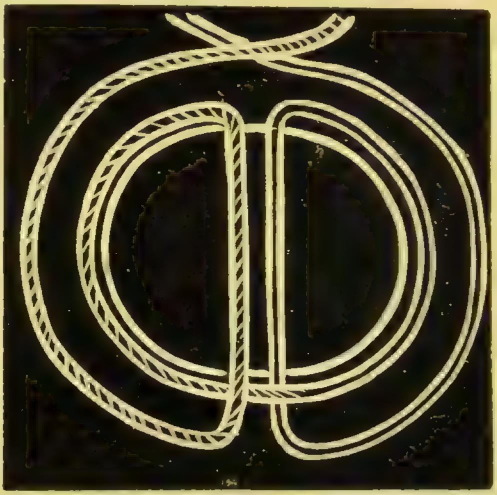

FIG. 9.—STAFFORDSHIRE KNOT, COMPLETED READY FOR TYING.

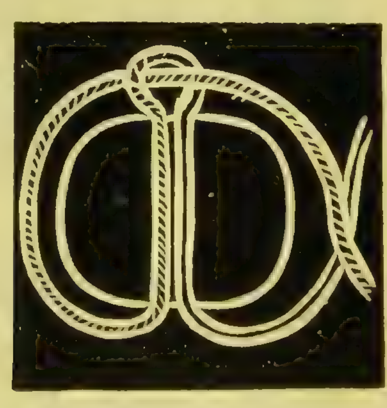

FIG. 10.—BANTOCK'S PEDICLE LIGATURE.

The **Staffordshire Knot** (Figs. 8, 9) attains the same end in a somewhat quicker way. After perforating the pedicle the loop is enlarged, brought back over the mass to be cut away, and underneath one of the free ends, which are now drawn tight, carried round the pedicle, and tied on the opposite side to the point first entered.

Another form is known as **Bantock's** (Fig. 10).

The Suture of Wounds.

The most convenient method for uniting thin layers of tissue, where there is no great tension, is the continuous suture (Fig. 11). This stitch crosses the long axis of the wound obliquely, or can be made transverse by looping each stitch, as in the buttonhole suture (Fig. 12). Sutures involving more than one layer, or a thick single layer of tissue, must be interrupted (Fig. 14), and the first loop requires two turns, otherwise it will slip; but a second loop will suffice;

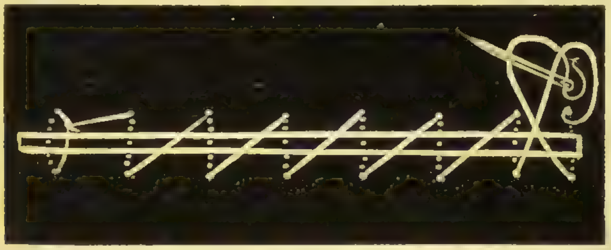

FIG. 11.—CONTINUOUS SUTURE DRAWN TIGHT, NEEDLE PASSING THROUGH LOOP TO FIX KNOT.

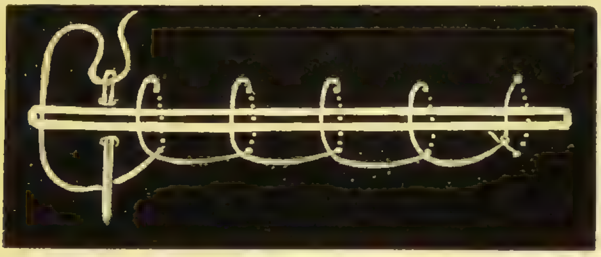

FIG. 12.—BUTTONHOLE CONTINUOUS SUTURE.

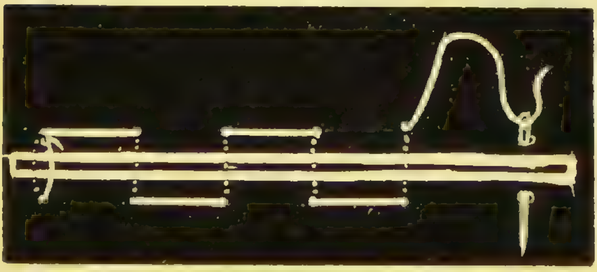

FIG. 13.—GLOVER'S CONTINUOUS SUTURE, EVERTING THE EDGES OF THE WOUND.

a third is generally unnecessary (Fig. 15). Sutures may be employed in stages, the deeper ones remaining buried. They are used when it is wished to bring the deeper parts of the wound accurately into apposition, so as to leave no cavity where discharges or blood-clot may collect. Each of the sets of tissues are separately drawn together, *e.g.*, peritoneum to peritoneum, muscle to muscle, fascia to fascia, skin to skin (Fig. 16). This, however, may take up unnecessary time, when the end can be just as well reached by firm bandaging, or when the tissues fall naturally together, and the chance of irritation round a buried suture is avoided. Deep-buried sutures are now always used in hernia operations.

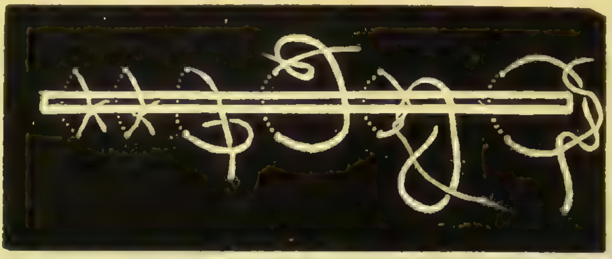

FIG. 14.—INTERRUPTED SUTURE.

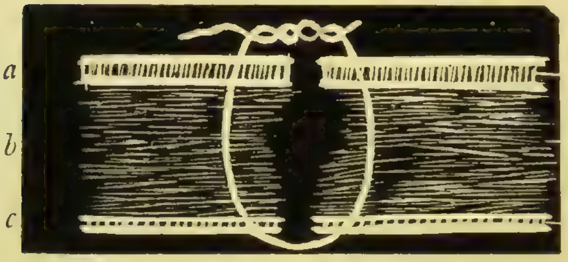

FIG. 15.—DEEP INTERRUPTED SUTURE.
a, Skin; *b*, muscle; *c*, peritoneum.

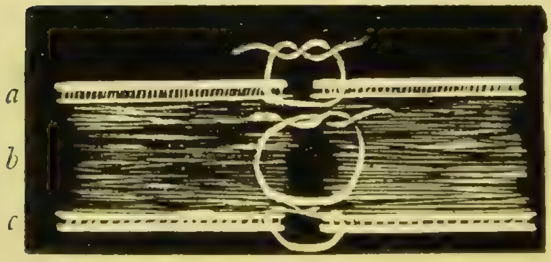

FIG. 16.—SUTURE BY STAGES.
a, Skin; *b*, muscle; *c*, peritoneum.

In removing sutures the knot is raised by forceps, the suture is then snipped through on one side, and withdrawn by moving the forceps towards the divided end at right angles to the line of the wound, so that the force exercised in withdrawing the suture tends to pull the edges of the wound together. Sutures may be removed from the face any time after forty-eight hours; from general wounds at the end of a week; where there is tension, they may stay from ten days to three weeks. Sutures in mucous membrane are allowed to fall out, or removed after healing when hanging loose.

Materials for Suture.

Silk of the same kind as that used for ligatures is most convenient, especially for the continuous suture.

Silver Wire.—The surface of the wire being smooth, no organisms can adhere, and therefore stitch abscesses are avoided, even when there is much strain; it is therefore specially employed where force has to be made in drawing the edges of the wound together. The suture may be fixed by twisting, by knotting, or by a combination of one loop and then a twist.

Horsehair, being also so smooth that organisms do not adhere, is the best for interrupted sutures, if no strain is required. It is especially useful on the face and for mucous membranes. Two turns must always be given to the first loop, or the knot will yield whilst the second loop is being tightened.

Silkworm, or Fishing Gut Suture.—Silkworms are grown large for the purpose, and when they are about to spin are drawn out and twisted up. It forms a suture tougher than horsehair, and more supple than wire. It is kept dry, but requires to be soaked for a quarter of an hour, or it will break in knotting. It cannot be used for a continuous suture. As in the case of catgut, organisms may be twisted up in it which are not afterwards destroyed, and hence suppuration occurs sometimes when it is used as buried sutures.

Catgut.—Both brown and green catgut may be used for sutures. The brown soon softens, only lasting a day or two; it is suitable for mucous membranes. Catgut is, however, less often employed, on account of the occurrence of stitch abscesses arising from spores of organisms twisted up in the preparation, and not afterwards destroyed.

Needles.—Round sewing needles are used only for the intestine and other mucous membranes. For skin the point of the needle must be spear-shaped, or like that of a trocar or chisel. Straight needles are generally best, for if curved they are apt to slip round in the fingers; but for fine work in a small space curved needles are wanted. The fingers should be used wherever possible, and needle-holders shunned. Strong needles with handles are required where force has to be employed in transfixing the tissues.

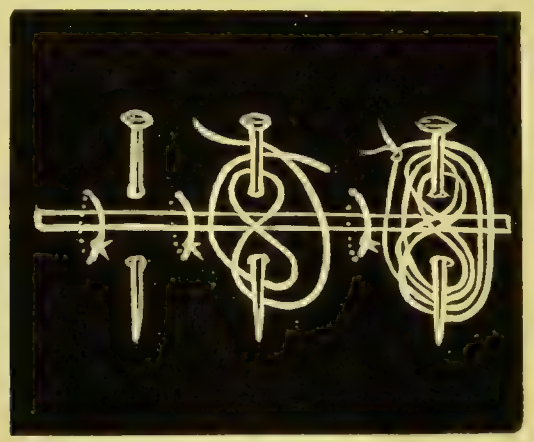

FIG. 17.—HARE-LIP PINS FIXED BY FIGURE-OF-EIGHT SILK.

Before the operation the sutures required are threaded and stuck into a piece of lint in the carbolic acid tray.

Pins are sometimes used instead of sutures. The edges of the wound are transfixed, and silk in a figure of eight wound round so as to squeeze the surfaces together. They are convenient for wounds of the lip, but are rarely used otherwise (Fig. 17).

The Drainage of Wounds.

Blood oozes from the deeper surfaces of a wound after suture. This is limited to a thin film when the surfaces naturally come together, or when held together by deep sutures or by firm bandaging; but blood-clot in varying amounts may collect, from which the serum is squeezed out and escapes from the wound, or is absorbed by the lymphatics into the circulation, otherwise it would separate the deeper surfaces of the wound and prevent healing. Tissues vary in vascularity, and therefore in the amount of oozing which may take place from their cut surfaces. The rapidity of absorption also varies greatly. If the peritoneum is generally healthy, and only a relatively small area be injured, rapid absorption of any exudation goes on through the stomata, aided by the digestive powers of the endothelial cells or their derivatives; but this power of absorption is much less if the wounded surface be relatively large, or the lymphatic stomata previously stopped. The lymphatics in connective tissue are capable of absorbing, but on a cut surface they are partly blocked by clot. Muscle is not only wanting in lymphatics, but is the source of much of the exudation. If the patient has to absorb even aseptic serum, he will not so quickly recover from the operation, but will feel depressed, suffer from headache, sleeplessness, lack of appetite, and may become slightly jaundiced. If the exudation definitely collects, it begins to undergo decomposition, and causes an elevation of temperature varying from 102° F. to 105° F. Even if the collection be let out by cutting a stitch or passing a probe, yet convalescence is disturbed, and some suppuration will almost surely follow.

If much exudation is likely to collect, a drainage-tube, generally of rubber, which has been kept in 5 per cent. carbolic acid, or of glass in abdominal and other cases where there is no danger of breakage, is inserted, either through the end of the wound which will be the most dependent in the position the patient will lie in bed, or through a buttonhole made in the skin for the purpose. The drain is removed at the first dressing, and the track left by an aseptic tube heals as soon as the rest of the wound. A patient should not take into his circulation at a critical time a quantity even of undecomposed serum.

For small aseptic wounds no drain is necessary, as the serum escapes between the edges before these have adhered. Large wounds require drainage for a day or two whenever the raw surfaces cannot be brought completely into apposition.

Germs which have escaped the antiseptic measures grow freely in blood-clot, and the leukocytes, in their attempt to digest the solid matter, die and become pus cells. A drainage-tube rapidly conducts away the decomposing serum and the pus cells, and so gives succeeding leukocytes the opportunity of overcoming the organisms which prevent the healing of the wound.

A wound containing such a number of organisms beneath its surfaces that they cannot be destroyed by antiseptic solutions is filled with antiseptic gauze, which, by rapidly removing the serum and débris before it can break down, allows the leukocytes to gain the mastery. Instead of such a wound discharging pus profusely—and each pus corpuscle represents a potential connective-tissue cell destroyed—it merely saturates the gauze with small quantities of serum, and very few cells break down. The surface of the wound is quickly covered with healthy vascular granulations, soon forming young connective tissue.

A strip of gauze is an excellent substitute for a drainage-tube whenever the discharge is thin. It is even superior in two respects : fluid can be soaked up against gravity, and there is no patent channel for organisms to creep in.

In the case of the ordinary drainage-tube with side holes, the outflow of fluid depends on gravity. When a tube cannot be placed in the most dependent part, a tube without side-holes can be employed so as to act as a siphon.

A glass tube inserted into the pelvis after an abdominal operation can be emptied at intervals by a syringe with a piece of rubber tubing on the nozzle. Continuous suction can be applied, *e.g.*, in the case of the bladder, by using a glass T-junction ; suction through the vertical limb is kept up by regulating the current flowing from an irrigator above, through the cross piece, into a vessel below.

Dressings—The Inner Layers.

Absorbent material is placed in contact with the wound, and consists of various forms of gauzes, which not only take up the fluids, but allow of evaporation, so that the discharges become dried albumin, in which organisms cannot thrive. Moreover, the impregnation of the gauzes with antiseptic materials prevents decomposition. Gauzes which have been sterilized by heat are cheaper as to first cost, but are troublesome to prepare, and rarely can be kept on more than a day or two without giving out a sour smell owing to some decomposition. Considering the apparatus required and the labour expended, sterilized dressings are no cheaper except where surgery is done on a larger scale.

Cyanide Gauze, introduced by Lister, impregnated with a double salt, the cyanide of zinc and mercury, and stained pink with rosanilin, is an excellent material. It is applied after being sprinkled with 5 per cent. carbolic acid so as to damp it. If wetted it may be rendered irritating, and if dipped in water the salt is washed out.

Perchloride of Mercury and **Carbolic Acid Gauzes** are less used on account of their liability to cause pustules on the skin when there is free sweating in hot weather.

Salicylic Acid and **Thymol Gauzes** are less powerfully antiseptic. The former is irritating to the nose.

Iodoform Gauze.—This is also an excellent material, but expensive, owing to the care required in its preparation in order that the iodoform shall be thoroughly and evenly distributed. It is especially useful for filling wounds and mucous cavities, on account of the iodoform not being absorbed.

Green Protective.—This is needed less often now that non-irritating gauzes are used. It is required, however, when the wounded surface and the gauze tend to adhere. Thus, when a portion of the stomach or intestines is brought to the surface, the exudation from the peritoneum is so great that the gauze will be firmly fixed to the intestines unless a piece of protective intervenes. In skin-grafting the gauze tends to stick, and tears off the grafts unless prevented by covering each graft with protective. Employed as a flange round the mouth of a drain, it protects the line of sutures.

Powders.—In order to increase the antiseptic properties of a dressing when there is much serous discharge, iodoform or boric acid powder may be freely dusted on the skin or between the inner layers of gauze.

Outer Dressings.

Absorbent Wool, rendered antiseptic by mercuric chloride, and stained blue, is a most satisfactory dressing as long as it does not come in contact with the wound or surrounding skin, especially in hot weather. A layer of iodoform wool is therefore placed next to the gauze. Where dressings have frequently to be changed, wood-wool or dried moss, enclosed in a layer of gauze, forms a cheap and good absorbent material.

Pink Protective.—A thin material covered with a layer of rubber on one side was at first used with the rubber inside to distribute the discharges evenly over the dressings. But the moisture so retained favours decomposition; it is far better to allow free evaporation, then the soaked dressing dries into a cake. But with the rubber outside the pink protective is used to prevent the dressings being soiled from without, *e.g.*, by urine, saliva, etc.

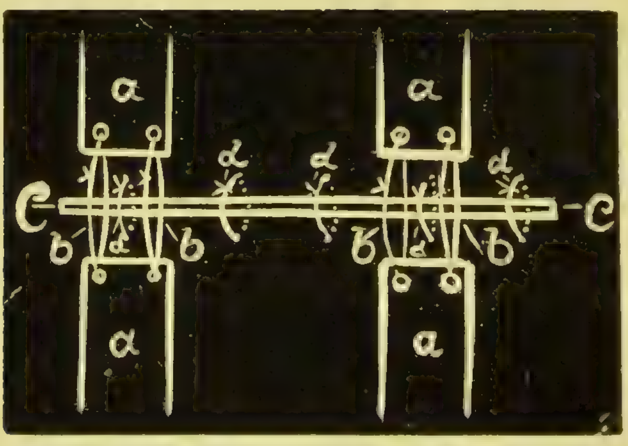

FIG. 18.—STRAPPING SUPPORTING INTERRUPTED SUTURE.

a, Strips of strapping; *b*, silver wire drawing together strips of strapping; *c*, line of union of wound; *d*, interrupted sutures.

Strapping, by which wounds were formerly drawn together, has in the main been replaced by sutures. But where there is much tension on the sutures relief is afforded by drawing upon the skin for some distance around by strips of strapping. A strip of strapping (Fig. 18) is laid on the skin at right angles to the line of union, from which its end is distant an inch or two. A second strip is placed on the opposite side. The two ends are then drawn towards one another by silver wire, which crosses the line of the wound without touching it. Strips of gauze can be slipped underneath the wire, and be changed without disturbing the strapping, which remains in position until the wound has healed.

Bandaging.

Bandages are made of more or less elastic material, in order to keep up a steady pressure, so as to prevent irregular muscular spasm, excessive oozing or disturbance of the wound. Ordinary kinds are composed of either linen, cotton, wool, or rubber. Crinoline muslin is the strongest, and is specially used for applying plaster of Paris. The most elastic material is sheet rubber, which can be easily washed in cold water, and is of service where firm but equable pressure is needed. Next in order of elasticity come the various forms of flannel.

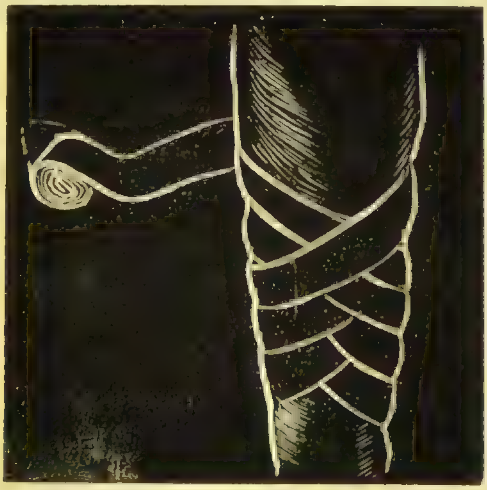

FIG. 19.—FIGURE-OF-EIGHT BANDAGE.

Bandages must be applied sufficiently tight to remain in position and exert proper pressure. Care must be taken that the circulation is not impeded, especially in the case of the arm, where venous congestion, paralysis, and contracture of muscle, and even gangrene, have resulted from constriction of the superficial veins.

The commonest method of bandaging is the figure-of-eight (Fig. 19). The roller is taken in the hand corresponding to the limb of the patient, and, commencing from within outwards, passes in front of the limb. The first turn or two should be in a circle, so as to make a neat edge. Then the bandage is carried over the front outwards and upwards, at an angle of forty-five degrees, taken round the back, then brought from behind over the inner side downwards and forwards. The turns should overlap for about one-third of the width of the bandage. A simple spiral bandage (Fig. 20) may be used

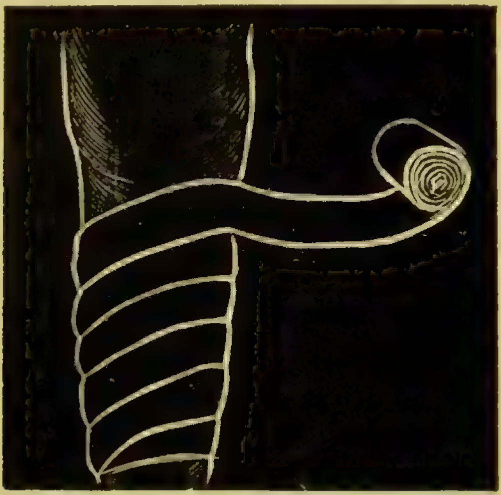

FIG. 20.—SPIRAL BANDAGE.

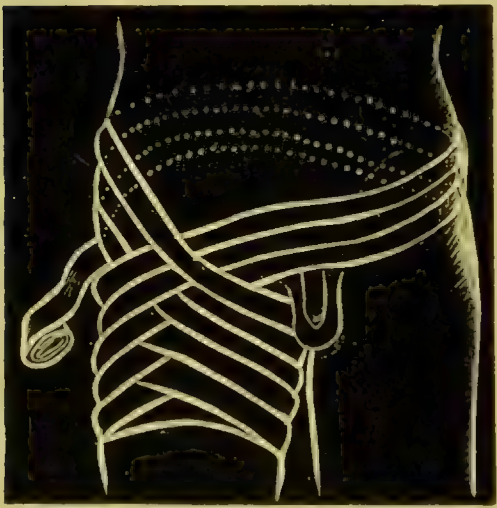

FIG. 21.—SPICA BANDAGE.

where the limb or dressing to be covered increases regularly; but in the case of the forearm the spiral must be changed for a figure-of-eight when the elbow is reached.

A spica bandage (Fig. 21) is used for the shoulder or hip. It consists of figures-of-eight for the limb, and of longer turns round the opposite shoulder or pelvis.

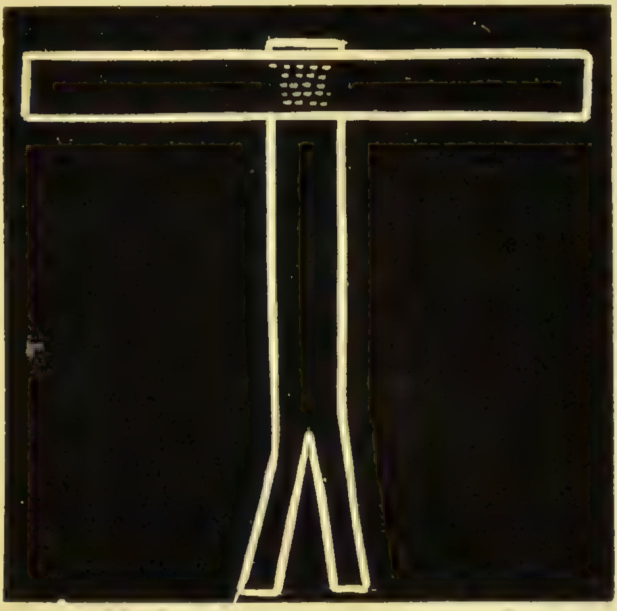

FIG. 22.—T-BANDAGE.

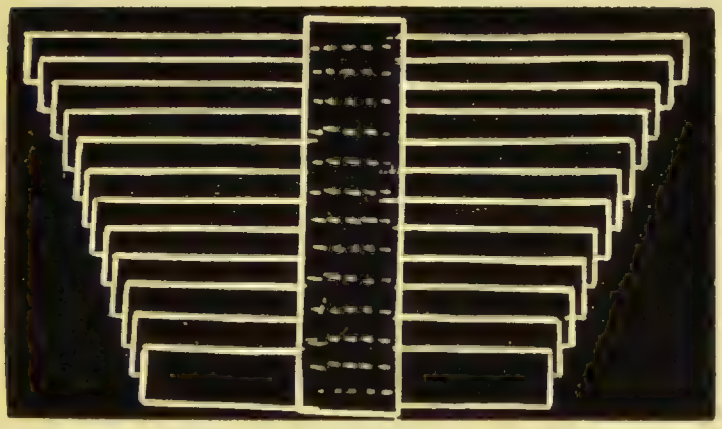

FIG. 23.—MANY-TAILED BANDAGE.

A T-bandage (Fig. 22) is made of two strips fastened together at right angles, one end of the broader to the middle of the narrower, the broader being split at its free end. It is employed especially to retain dressings on the perineum.

A many-tailed bandage (Fig. 23) is made of strips of equal length fastened together at the middle, so as to overlap each other by about half their width. It is suitable for the chest and abdomen. The free ends are brought round and pinned together in front.

Triangular handkerchiefs can be used in a number of ways, especially for temporary dressings where no pressure is required.

Slings.

A triangular handkerchief is made either by cutting along the diagonal of a square of cloth or by simply folding. When the sling is required to support the hand, forearm, and elbow, the ends forming the angles of the base are tied round the neck, the end forming the apex is brought round the back of the elbow and pinned to the front surface. The portion of the sling between the arm and the body must pass over the opposite shoulder so as to support the hand (Fig. 24). When, however, it is necessary to relieve one shoulder from pressure, the front end may be taken below the armpit and over the back of the shoulder to meet the end lying between the arm and body (Fig. 25).

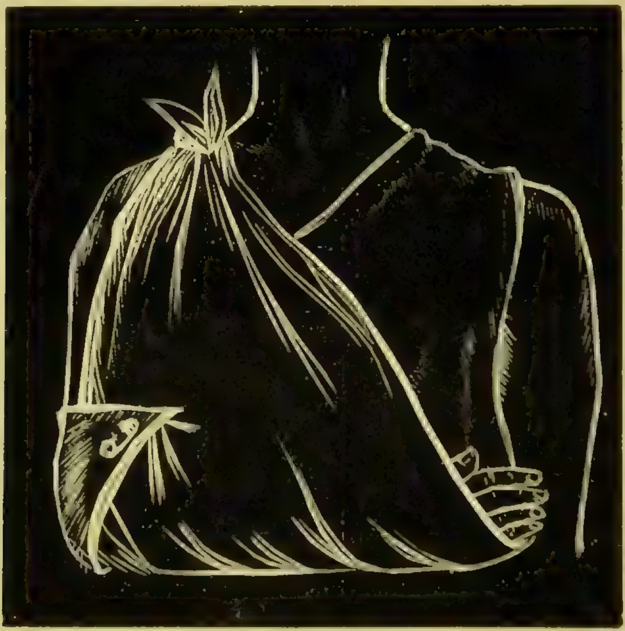

FIG. 24.—SLING SUPPORTING ELBOW AND HAND.

When a sling is required to support the wrist only, and to leave the elbow to hang freely, the triangular handkerchief

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is folded like a neckcloth, and the end between the arm and body must be carried over the shoulder of the same side, or

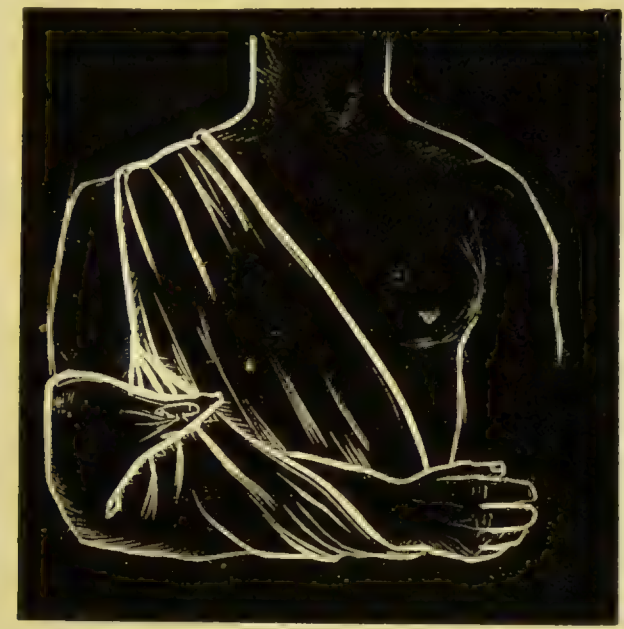


FIG. 25.—SLING SUPPORTING ELBOW, RESTING ON ONE SHOULDER ONLY.

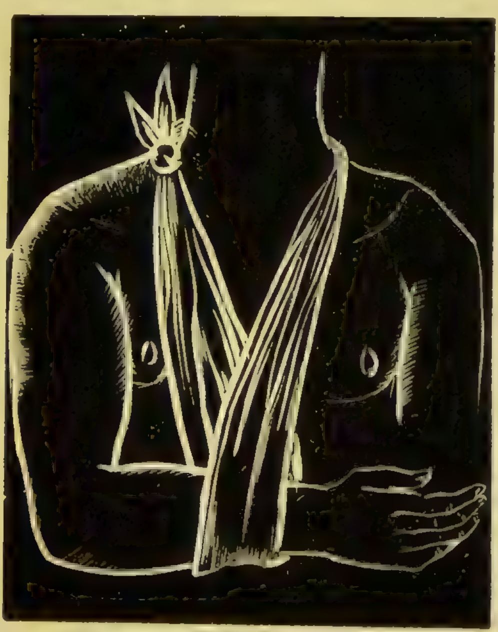


FIG. 26.—NARROW SLING SUPPORTING WRIST.

the hand will tend to slip out (Fig. 26). A sling is also made for the wrist by forming a clove hitch with a bandage (see Fig. 3).

Subsequent Dressings.

When the discharge soaks through the bandage, the spot is immediately covered with some iodoform or boric acid powder and antiseptic wool. When the dressings are fairly saturated they must be changed, and then the drain, if one has been used, is removed. If the discharge does not penetrate the dressing, it need not be changed for a week or ten days, and then the sutures are taken out. Sutures should not be left in the face for more than two or three days, in order to escape permanent marks. Deep sutures in the abdominal wall are left for three weeks unless there are signs of ulceration. Sutures in the palate or perineum are left until they are quite loose. When the sutures have been removed, and the wound is quite dry and adherent, it is sufficient to apply a collodion dressing on the skin.

A collodion dressing consists in dusting the surface with boric acid powder, spreading over it a very thin layer of wool, and saturating it with collodion. A collodion dressing may be applied for the first dressing where the wound is on the face or lip, or is small and not likely to be disturbed by rubbing. An open light must not be brought near, or the 'gun-cotton' will explode, and a patient has thus been burnt to death.

Even when a drainage-tube is used wounds are rarely irrigated. Irrigation is reserved for abscess cavities and for those wounds which communicate with mucous membranes.

When a wound is healing by granulation, and the discharges become small, crusts collect, beneath which ulceration and the formation of pus goes on; also the dressings tend to stick to the wound. Frequent dressing is therefore required to keep the wound free from these crusts, and antiseptic ointment may be spread on the gauze to prevent sticking.

The Nursing of Surgical Patients.

A surgical nurse must clearly understand the importance of that methodical cleanliness which constitutes antiseptic surgery. It is through her hands, and less often through her clothes, that infection may be carried to her patient.

Purulent discharges from the mouth, nose, or ear entirely unfit either a surgeon or nurse from attending a surgical case. It is the duty of both surgeon and nurse to see that all the surroundings of the patient, including the drainage of the house and the water-supply, are in good order. The nurse has to keep the patient clean, special care being taken with the hands, feet, nails, and hair. The heads of women and children must be freed from vermin, the hair being cut short whenever needful.

Preparation for Operation.—A purge suited to the patient is given overnight, and a soap-and-water enema a few hours before the operation. Should the enema fail to return, the nurse must wash out the rectum through a tube. A vaginal douche is required if there is a discharge, and must always be given before vaginal operations. To disinfect thoroughly, a speculum is passed, and the vagina syringed and wiped out with permanganate, or sublimate 1 in 5,000, after which a pledget of iodoform-wool is inserted.

The patient is kept without food before the operation for a period varying with each case, and the nurse must see that a child does not get food on the sly. Just before the operation the patient must be told to pass water; in the case of a man who cannot, the surgeon is informed. The nurse passes the catheter for a woman, and, indeed, in all pelvic operations a catheter should be passed to make sure that the bladder is empty. A nurse should never attempt to pass the catheter until the orifice of the urethra is fully in view, whether the woman is on her side with the legs well flexed, or on her back with the legs apart. There must be a good light from a candle if daylight is not available.

For operations a table is to be preferred, not only for the surgeon's convenience, but because the bed can be comfortably arranged for the subsequent reception of the patient. The table should be well covered by blankets, for paralysis of the arm has occurred from compression against a hard table during an operation. The patient lies on a mackintosh, and the area of the operation is surrounded by dry towels, over which are laid towels wrung out of 5 per cent. carbolic acid.

During an operation the parts not exposed are kept well covered, and hot-water bottles may be placed in blankets between the legs or under the arm-pits. Young children should be swathed in cotton-wool.

After the operation the patient's head is kept low and turned to one side, so that vomit and saliva can escape into a spit-cup. He is covered up, and hot-water bottles placed in the bed-clothes until he gets thoroughly warm and begins to sweat. Hot-water bottles must not be in actual contact with the skin, for burns are easily produced in this way. Hot beef-tea and milk, with or without brandy, are given as a nutrient enema when there is much collapse, or large rectal injections of hot water when the collapse is due to loss of blood. Nothing should be given by the mouth, except teaspoonfuls of hot water, until vomiting and nausea have ceased. If vomiting is severe, an occasional lump of ice, a little dilute vinegar, sal volatile, eau-de-Cologne, or brandy, may relieve it. In abdominal operations the patient is kept without food by the mouth for twenty-four hours, nutrient enemata being administered as required. Children should not be kept without food by the mouth after severe operations, but sips of hot milk are to be given every half-hour, or oftener, as soon as they wake up, for in them vomiting is not important, and they will seldom submit to enemata.

Convalescence.—After recovery from operation in favourable cases, the nurse's special duties are limited to protecting the patient from sudden variations in temperature, from indiscretions as to diet, owing to the appetite increasing faster than the digestive powers, and from over-exertion, since energy often returns more quickly than the muscular strength.

In less favourable cases the variations in the temperature, pulse-rate, and rate of respiration have to be charted, along with a record of the urine and bowels. The record of the pulse is quite as important as that of the temperature. Special means have to be adopted to prevent bed-sores.

Other details are given under special subjects, *e.g.*, Abdominal Operations; Fracture of the Spine.

Alcohol for Surgical Cases.

Alcohol is unnecessary for a patient whose wound is healing by first intention and whose general condition is satisfactory. It ought not to be given to a patient suffering from fever owing to threatened suppuration.

A patient is allowed to take light wine or beer or diluted spirit with his meals according to his custom; it aids his digestion and keeps him contented. But a patient who has taken alcohol in excess must be rigidly cut down to a limited amount.

Alcohol is required in small amounts for shock. About a teaspoonful of brandy in hot water every quarter or half-hour, or $\frac{1}{2}$ ounce of brandy in an enema every two hours, is all that can act as a stimulant; beyond this alcohol tends to make shock worse by acting as an anæsthetic and dilating peripheral bloodvessels. After recovery from shock the alcohol is discontinued unless there are further indications. These are weakness of the pulse and inability to take food or to retain enemata satisfactorily, and the patient has to be tided over these dangers by champagne, or brandy and soda-water, given in a teaspoon at short intervals. Hot meat extracts, coffee or tea, should always be tried as well, to avoid excess of alcohol.

Alcohol is definitely of service in all cases of prolonged and extensive suppuration. After the evacuation of retained pus, stout or port-wine does good for a time, but as the beneficial effect wears off it must be supplemented, not by more alcohol, but by fresh air.

Delirium.

Acute septic delirium is prevented by antiseptic measures applied, *e.g.*, to a punctured wound or compound fracture. It becomes dangerous when complicated by septic pneumonia. The treatment then required is the most thorough antiseptic measures applied to the site of absorption, the administration of streptococcus antitoxin and of alcohol, whilst the patient is watched for signs of metastatic suppuration, empyema, or pyæmic abscess in joints or in the subcutaneous tissue.

Simple traumatic delirium may follow a fracture, *e.g.*, of ribs, and slight pneumonia may also be occasioned. The condition is not dangerous, and is treated by rest, purgation, and low diet. Delirium is caused by debility in young children, old people, and exhausted adults. The patient's mind wanders at night. Nourishing and easily digestible food is required at frequent intervals, especially on waking in the small hours of the morning. When it is owing to insufficiently deep sleep, the patient should get up and be sent into another room or into the fresh air, or at least be prevented from dozing too often in the day.

Delirium tremens complicates operations done of necessity, and takes place after wounds and accidents of all kinds. The amount and kind of alcohol taken previously is very variable. The condition is not dangerous unless attended by septic complications. Sometimes a mild attack supervenes in the third or fourth week, *e.g.*, after a simple fracture. Head injuries, including slight ones, in patients who have taken alcohol freely, require special care. All patients who show signs of tremulous fingers or tongue should be watched, lest in a sudden attack of mania they damage themselves or others. The question of the administration of alcohol is one for the exercise of judgment in every case. If the patient takes plenty of food, no alcohol at all should be administered. Sal volatile and tincture of cardamom or capsicum prevent depression and nausea in the morning. If insufficient food is taken both by the mouth and rectum, alcohol is a temporary necessity.

CHAPTER II.

POSITION—ANÆSTHESIA—OPERATION ACCIDENTS AND INDICATIONS.

Position of the Patient during an Operation.

A PATIENT should not stand even during a slight operation, or whilst being dressed. He should recline in a chair or on a couch, for a puncture, *e.g.*, in tapping a hydrocele or pricking a finger, lest it make him faint.

During an operation under an anæsthetic the patient is usually on his back, with his head on a pillow. Nitrous oxide gas and also a little ether may be given to a patient reclining in a dental chair; but chloroform is a great source of danger when given in this position, even for the extraction of one tooth; if many have to be removed at a time, the patient is best treated as in a serious surgical operation. If the patient cannot lie down owing to respiratory obstruction, only very little chloroform is given, or cocain is injected subcutaneously.

Operations on the mouth and throat are often done with the head hanging below the trunk. The objection to this is the increase of venous hæmorrhage. In operations on the upper jaw or tongue, it is generally more convenient to prop up the patient, and then the chloroform must not be pushed enough to blunt the laryngeal reflex. Adenoid vegetations can be removed whilst the head is low, and turned to one side so that all the blood shall run out of the lower angle of the mouth. The head should be well raised during operations on the brain to avoid congestion and hæmorrhage.

In operating upon the chest for an empyema, the patient is turned on to the sound side. If this renders breathing difficult, the patient is kept on his back, and the affected side is brought over the edge of the operating-table, which should then be a high one, or the patient may be turned over so as to lie on the front of the affected side.

In operating upon the stomach and liver, a bolster or sandbag is placed behind. In order to expose the kidney, the patient is laid on the opposite side across several sandbags. In order to keep the intestines out of the way in operations in the hypogastric region and pelvis, the pelvis is raised (Trendelenburg's position), and a better view is in this way obtained. But the diaphragm must not be impeded.

For operations upon the vagina, perineum, and rectum, the lithotomy position is employed, the legs being kept apart by a crutch. But the lithotomy position is not always necessary, or even so convenient as others. Thus, piles may be ligatured with the patient on the side, the upper leg being well flexed at the hip. This lateral position may be used for excision of the rectum. Another convenient position for operations on the rectum is that in which the cadaver is placed whilst dissecting the gluteus maximus muscle. The patient's knees rest on a chair on either side of the surgeon. This position is the same as the genu-pectoral position ; the intestines fall away, and the atmospheric pressure dilates the rectum or vagina.

General Anæsthesia.

This is an essential part of all operations except where local anæsthesia suffices. Whenever general anæsthesia is induced, there should be at hand a gag, sponge-holders, trachea-tubes, a hypodermic syringe, nitrite of amyl capsules, and a bottle of sal volatile.

Patients should take only a light diet the day beforehand, and nothing for three hours before, unless it be milk or beef-tea. Tooth-plates must be removed from the mouth, and all tight clothing undone. The rectum and bladder should be empty.

Nitrous Oxide Gas.—This is employed for short operations of a minute or two when complete muscular relaxation is not required. The bag attached to the inhaler is filled slowly from the gas bottle; if it be allowed to escape too fast, ice forms in the tube and blocks the escape. The patient is made to inspire the pure gas; this induces a suffocating feeling which compels him to breathe more deeply, so that consciousness is rapidly lost, and the arms, after slight twitchings, drop to the side, the reflex contraction on pinching the eyelid is lost, and the breathing becomes stertorous. If a very little air be admitted at the right moment, the face does not turn blue. The patient is rigid; but the rigidity of the lower jaw is easily overcome, and can be opened by the gag if a prop has been inserted beforehand, so as to prevent complete closure. No sensation is caused by the operations lasting a couple of minutes, and recovery takes place in some two minutes more. The patient can sit or lie, as most convenient. A little ether being given, the anæsthesia may be prolonged to five minutes without greatly hindering the recovery. Oxygen given with the nitrous oxide allows the anæsthesia to be prolonged by a couple of minutes or so.

Nitrous Oxide Gas and Ether.—This is the general anæsthetic for adults, except in hot climates, where only chloroform can be used. As soon as the nitrous oxide gas has abolished the reflexes, the ether chamber of the inhaler is connected with the bag, so that the air respired constantly receives additions of ether vapour. If an insufficient amount of gas is used, coughing will ensue on turning on the ether. If no gas be used, the inhaler must be kept tightly over the patient's face, so that he has to breathe his own expired air, the carbonic acid of which diminishes the irritation from the ether vapour, although in not so pleasant a manner as nitrous oxide gas.

When the patient is sufficiently anæsthetized, or before if any spasm or cough is excited, the inhaler is raised from the face every sixth respiration, then gradually increasing the frequency with which air is inspired. But too much air must not be given early in the operation, for either the patient will not be anæsthetized without much spasm or cough, or retching and vomiting will ensue, during which the administration has to be stopped.

When the reflex by pinching the eyelid is lost, ordinary operations are immediately begun. This anæsthesia is, however, insufficient for certain painful operations, especially that of dilating the sphincter ani; for this the ether must be pushed until the soft palate is relaxed, and flaps backwards and forwards with a stertorous noise. If not, there is struggling and bearing down. When, however, the stretching is complete, the patient may be allowed to come out a little for the rest of the operation. The cutting through of the sensitive skin requires a deeper anæsthesia than the rest of an operation. Except during the deepest stage of anæsthesia, a reflex from the superior laryngeal nerve causes closure of the glottis whenever it is excited by saliva or blood.

Ether is the safest general anæsthetic for adults, for fatal accidents do not arise, as in the case of chloroform. Extremely exhausted cases of abdominal obstruction may no doubt die whilst ether is being administered. Such cases are best operated upon without any anæsthetic at all, or a local anæsthetic is used for the skin incision.

Ether is unsuitable for operations on the mouth or larynx on account of the greater salivation, and the tendency to vomiting unless in deep anæsthesia; in operations on the brain ether produces excessive venous congestion, and it tends to aggravate bronchitis, especially in old people. Ether cannot be used in hot climates on account of the rapidity of evaporation; a patient cannot be anæsthetized unless by nearly asphyxiating him. Ether cannot be employed in war on account of its bulk. The vapour is inflammable, and may be ignited by a hot cautery point or by a lighted gas-jet above the patient's head. Chloroform is substituted for ether when the cautery is required for the head or neck, and when operating at night open lights should be kept near the patient's feet, and away from the head.

Chloroform.—Chloroform is a much more powerful anæsthetic than ether. It is the only anæsthetic which is portable and suitable for hot climates and military surgery, but in other circumstances an unnecessary risk attends its general use. When administered to healthy animals, they are quickly narcotized, and dogs, monkeys, or rabbits are apt to die suddenly, in spite of artificial respiration, whereas the breathing when arrested during etherization is started again by artificial respiration, supposing that there is no obstruction in the air-passage. Chloroform when carefully administered is an admirable anæsthetic, and the fact that there are those who have given it to tens of thousands of cases without a death shows that the greater number of chloroform deaths are avoidable by means of experience and the closest watchfulness. Yet deaths in young and healthy adults suffering from some trivial malady are, as a matter of fact, constantly occurring; the respiration and heart are suddenly and irreparably stopped, owing to a momentary concentration of the chloroform vapour in the lungs. Anyone who gives chloroform must turn his whole attention to the patient, and disregard entirely the operation; the more deeply the anæsthesia, the greater the likelihood of dangerous symptoms. There are three signs of danger—a shallowness of the respiration, a diminution in pulse-tension with pallor of the face, and a dilatation of the pupil; these signs are generally noticeable in the order given, although it is quite possible to get a few shallow and irregular respirations after the heart has stopped.

Chloroform should be dropped on a layer of lint or a special mask held at a short distance from the mouth; this allows of plenty of air, and the chloroform vapour does not rise above 4 per cent. Moreover, the lips will not be blistered by contact with the chloroform. It is very dangerous to have any excess of carbonic acid inhaled with the chloroform; where there is a tendency to asphyxia, the patient should only be slightly anæsthetized. Chloroform is conveniently administered by a ball-syringe which drives bubbles of air through chloroform, and which carry with them some chloroform vapour out through a tube. This tube can be inserted into the nose or mouth, and thus the surgeon can operate without hindrance when the patient does not require to be deeply anæsthetized, and it is sufficient merely to restrain muscular movements. If teeth are extracted under chloroform, the patient must be lying down, and not sitting in the chair, for nothing is more dangerous than the latter position.

Young children are given chloroform. It frightens them less, but it is none the less dangerous for mouth and throat operations except in small quantities. Many fatal cases have occurred in the operation for adenoid vegetations. Children above ten should be given gas and ether, using a small face-piece.

If the respiration or heart becomes feeble, the patient's mouth must be at once cleared, and, the head lowered below the level of the trunk; a child is completely inverted. Artificial respiration is commenced by several forcible expressions of air, so as to get rid of the excess of chloroform before any aspiration is made. The tongue is drawn forwards by forceps, or the elevation of the jaw may suffice. Whenever artificial respiration, inversion, and drawing forwards of the tongue are not sufficient, tracheotomy should be performed, and the thorax inflated through the wound, and this should be done within a minute or two of the arrest of respiration if there is any possibility of foreign matter having got into the trachea.

Other methods may be at the same time included, such as rhythmic pulls on the tongue, nitrite of amyl inhalations, flicking the chest with a wet towel, rubbing the ribs with the knuckles, putting a hot sponge on the precordium.

Electric stimulation is not likely to rouse an unconscious patient, and, indeed, if the current were to reach the heart, it would diminish action rather than increase it, by exciting the vagus influence.

Injections of alcohol and ether to any amount can only add to the anæsthesia, and the stimulating effect can be just as well got by injecting a little weak ammonia.

A.C.E. mixture is a solution of chloroform in alcohol and ether, and, seeing that the chloroform is diluted, it is more difficult to give an excessive dose; yet on this very account there may be a tendency to deprive a patient of air, and so incur great risk.

Chloroform and Morphine Narcosis.—This is especially useful in brain operations where venous congestion has to be avoided and deep anæsthesia is unnecessary. About $\frac{1}{3}$ grain should be injected a quarter of an hour before commencing the chloroform, which must be given very sparingly throughout.

Chloroform and Cocain.—For prolonged operations on the mouth, such as cleft palate, and for intralaryngeal operations, chloroform may be first administered, and afterwards cocain painted on, so as to diminish the amount of chloroform afterwards needed.

Chloroform as an Analgesic.—During labour, and during the acute stage of biliary or renal colic, some cotton-wool or blotting-paper is placed in the bottom of a tumbler and saturated with chloroform, and the patient then holds the glass over the mouth and nose. There must be no chloroform as fluid in excess in the glass, nor must the patient help himself to more, lest he spill some on the pillow when drowsy, and so poison himself. Another method of self-administration is by means of the ball syringe, which the patient ceases to work when he becomes drowsy. The bottle must be suspended by a hook lest it be overturned, and the rubber tubes properly connected so that no fluid chloroform can be pumped out.

Local Anæsthetics.

Cocain Hydrochlorate.—A 20 per cent. solution is used for the examination of and operations upon the nose and larynx. It may be applied by a brush, by a spray, or by a plug of cotton-wool inserted up the nose. Not more than ½ grain must be employed at a time. A solution of about 2 per cent. is likewise in general use for anæsthetizing the cornea and conjunctiva, and permitting operations on the eye. This solution may be syringed into the urethra previous to operating. Injections of 5 per cent. solution may be made subcutaneously along the line of an incision by thrusting the needle as far as is required, and then expressing drop by drop as it is withdrawn. It has also been injected into the gum previous to the extraction of teeth. But such injection methods are unsatisfactory, for the patient is caused the pain of the preliminary puncture, is only partly anæsthetized, since not more than ½ grain can ever be safely used, and being awake may interfere with the rapidity with which the operation is performed. Therefore, nitrous oxide gas alone, or in combination with ether, is generally employed, and cocain injections reserved for those to whom it is dangerous to give a general anæsthetic. It must be remembered that whereas a mucous membrane is anæsthetized, the effect does not extend far beneath the surface.

Cocain-Poisoning.—This is to be avoided by never using more than ½ grain. Although larger doses may enable more to be done, there is a risk of unforeseen and fatal accidents. Even with ½ grain a patient may have creeping sensations, turn faint, begin to retch, ramble in his talk, or become excited, with the result that the surgeon has to watch by his patient for half an hour or an hour.

Local Anæsthesia by Cold.—This is conveniently done by the chloride of ethyl spray, which does not cause such aching afterwards as the ether spray. It is very useful for momentary operations, such as incising superficial abscesses, snipping off warts, external piles, etc. The freezing should not be continued beyond the formation of the hoar frost, and had better not be employed in old people, or gangrene may start.

Chloride of ethyl may diminish the pain of tooth extraction when applied, but as inhalations to any extent may be dangerous, nitrous oxide is better.

Accidents which may occur during an Operation.

Many an operation is at its commencement more or less exploratory until the diagnosis is confirmed, and its plan should admit of a change at any moment. Thus, all tumours must be first cut into, for it is easy to confound some inflammatory condition with a cancer curable only by a free excision.

Injury to Large Vessels.—Injuries to large vessels are now rare, owing to a better knowledge of their course, and operations can be carried out leisurely on a patient deprived of all muscular movements instead of being hurried through amid cries and struggles. The danger from air entering the veins was great when with each expiration and struggle the veins were suddenly distended, and then as suddenly emptied by a violent inspiration. This danger has been done away with by anæsthetics, and only comes into play in injuries such as cut throat. Wound and ligature of the portal vein is immediately fatal, and the same is true, although more slowly, in the case of the thoracic duct. Wound and ligature of the common carotid increases the gravity of an operation in the neck by exposing the patient to softening of the brain. Gangrene of the arm or leg may be caused if the main artery or vein or both should have to be ligatured.

Obstruction to Respiration.—Death may suddenly occur during an operation from blood, pus, vomit, piece of a tonsil or tumour, etc., getting into the trachea, and may be prevented by operating with the head hanging below the level of the trunk. If such an accident happens, prompt tracheotomy is required.

Opening of Important Cavities.—There is now no danger from the accidental opening of any one of the important cavities, provided that the fact is recognised and the cavity closed again in the proper manner; but to overlook a communication between the peritoneum and the intestines or bladder would lead to a fatal termination.

Errors from crass ignorance are now rare, for the power of obtaining legal redress keeps the unqualified practitioner from meddling with surgery.

Injury from Working in the Dark.—An injury to an important structure may take place during the subcutaneous division of contracted bands, in wrenching an ankylosed joint, or when the depth of a wound is out of proportion to its superficial extent. All such accidents are inexcusable now that open wounds can be so safely made.

General Indications for and against Operations.

The surgeon has to place himself mentally in the position of the patient, and, having formed an opinion, must explain the grounds upon which that opinion is based in terms best suited for his comprehension, and then leave to him, his friends or relations, the decision for or against an operation.

The reasons for or against an operation are always relative, and never absolute. One person may desire an operation which offers but the faintest hope; another may elect to die without it. One patient may need some speedy even although risky treatment, because he cannot remain long out of work, whilst another can afford to be an invalid. A disease may be an absolute bar to the practice of an active calling, yet give but little trouble to a sedentary person. An operation for an otherwise incurable disease must be considered in relation to the patient's expectation of life. A cancer which will end fatally in two or three years ought to be operated upon in a young person, and yet in an old one it may be best to do nothing.

There is now so much greater certainty in surgical methods that well-grounded confidence can be expressed in favour of the greater number of operations; yet care must be exercised in using such words as 'absolutely safe' or 'a certain cure' in respect to any operation. It is better to avoid a direct answer to such questions by comparing an inappreciable risk to that run every day in crossing a street or in the various modes of travelling. If an operation presents some chance of immediate or ultimate failure the statistics of the operation may be quoted, and the patient's position defined as an average case, or as above or below the average in gravity.

1. Cases of primary surgical urgency. There can be no contra-indications to an operation which alone can prevent life from ending in a few hours or days. The patient's condition may make the chances better or worse, but the operation must be carried out unless consent is absolutely refused. Such are operations for acute hæmorrhage, laryngeal obstruction, hernia, retention of urine, etc.

2. There are no contra-indications to an operation for a disease which without interference would prove fatal. Instances of this are the removal of stone from the bladder, or of an ovarian cyst from the abdomen. The only bar to such operations would be the existence of such complications as severe renal or heart disease.

3. Abnormal conditions, such as congenital deformities, not dangerous to life, yet not curable except by operation, are treated unless life is thereby endangered, particularly when the patient is prevented from taking part in the ordinary duties of life.

4. Difficulties may arise in deciding about an operation which is known to be uncertain in its cure—*e.g.*, for cancer—

especially if some less dangerous measures may be undertaken in immediate palliation of the symptoms. If, however, by removing the cancer a time of health of at least six months can be ensured, removal should be chosen. An operation which merely offers a more ready cure than other kinds of treatment will always be of doubtful expediency, yet may be undertaken when time is of importance to the patient.

A number of general conditions may tend to make the prospect of a good result less likely.

Age.—Very young infants bear operations involving any loss of blood badly. The time of teething has to be avoided, and children must be closely watched before operation against any sore throat, rash, or fever. Operations in old age which do not last long, and which are not attended by much loss of blood, are well borne. In both children and old patients great care has to be taken to protect from cold.

Menstruation.—During menstruation, operations are, as a rule, postponed. They would be objectionable on the pelvic organs from the increase of vascularity and the tendency to inflammatory complications. There are no important reasons against operating on other parts except that women dislike operations at this time. Those of urgent necessity, such as for strangulated hernia, done during menstruation, pursue the ordinary favourable course.

Pregnancy.—Whenever possible, all operations are avoided during pregnancy. Those on the pelvic organs may excite abortion. Operations such as the removal of the breast for cancer, ovariotomy, or an amputation, may be done. The union of fractures may be delayed. Excision of joints during pregnancy has utterly failed, so amputation must be preferred unless the case can wait.

Acute Diseases.—All suppurative complications require treatment as early as possible. In septicæmia and pyæmia every endeavour must be made to find the starting-point of the lesion by exploring all possible foci. Advanced pyæmia may be arrested by laying open all abscesses and stopping the continuous absorption.

Chronic Affections.—Chronic affections of the heart, lungs, kidneys, and liver, may negative an operation, but the local disease can aggravate any of these conditions, and a general improvement follow active measures. The treatment of a local tubercular lesion may improve the lungs. Syphilis, rheumatism, locomotor ataxia, diabetes, and alcoholism, are generally treated medically even for local lesions, yet when such measures fail to relieve, surgical methods may be tried with advantage.

Hæmophilia.—This is an absolute bar to any operation except for a danger immediately threatening life. After the division of any bloodvessels, however small, the wound oozes continuously and freely. A considerable diminution in the amount of hæmorrhage is generally to be obtained by a course of calcium chloride, 30 grains a day, before and after the operation.

Epilepsy.—An epileptic may have a convulsion during an operation, but there is no great danger if the breathing be attended to.

Anæmia.—Young anæmic girls are bad subjects for operation, and may faint and die suddenly. No operation should be undertaken in a markedly anæmic patient unless for the relief of some condition immediately threatening life.

Leukocythæmia, as distinguished from leukocytosis of inflammatory origin, is also a bar to operation.

Obesity.—Obesity increases the gravity of an operation, owing to difficulties in breathing, turning in bed, etc. Obscuration of the disease by fat increases the difficulty of diagnosis, and of the operator in exposing the part. Moreover, fat people are anæmic, liable to faint, blood oozes freely, and has a diminished tendency to clot. They are more liable to erysipelas, to sloughing and gangrene, and, if the obesity is due to alcohol, to delirium tremens. Obesity complicates the removal of the breast for cancer, because the wound is so much larger; it complicates umbilical hernia by rendering reduction difficult; it complicates urinary troubles by rendering the bladder so much further from the surface.

Permission for an operation is necessary except in cases of primary surgical urgency. No operation should be done without a full explanation given, and an unreserved permission obtained either from the patient or from the parents or guardians. Chancery wards and lunatics can only be operated upon by special permission.

CHAPTER III.

ACCIDENTS.

Shock—Collapse.

A MORE or less rapid failure of the circulation and respiration is produced in many and very various ways—by extensive burns or immersion in cold water, by a snake-bite, by a blow on the head, from fright, or from a lacerated wound. Although of complex origin, three points may be distinguished in their order of importance: (1) A failure of pulse-tension, attended by dilatation of arterioles, especially in the intestines, so that an excess of blood collects in the abdominal veins and in the skin, causing undue loss of heat, the temperature falling to 97° F. or below; (2) a feeble heart-beat, the rate being at first quickened, then slowed; an insufficient amount of blood is returned to the heart, the coronary arteries are imperfectly filled at each systole, and so the heart muscle suffers; (3) the vital centres in the bulb do not receive enough blood, the vaso-constrictor centre loses its power, the peripheral arterioles relax completely, and the blood tends to collect in the veins, the respiratory centre gets weaker, so that less oxygen reaches the blood, less carbonic acid escapes, and thus the power of the heart muscle is further weakened.

Recovery takes place in a reverse order; respiration oxygenates the blood, which excites a more powerful heart-beat, and sufficient oxygenated blood reaches the bulb and spinal cord, so that vasotonus is regained. The temperature gradually becomes normal.

The commencement of the shock may specially affect one of the above factors. The heart muscle may first give way after long exertion, especially when from want of training or from disease muscle fibres have been replaced by fat. Paralysis of the vaso-constrictor nerves of the abdomen may be brought about reflexly by a blow on the stomach, or during an operation which interferes with depressor fibres in the neck. The simplest cause of shock is the loss of blood, although some immediate compensation takes place by the contraction of arterioles and the absorption of fluids from the tissues.

Whenever the patient is so affected by shock that death is threatened, there are two important measures to be carried out:

Artificial Respiration, which is continued until the patient breathes sufficiently to cause the blood in the superficial capillaries to lose any blue tinge.

Introduction of Fluid into the Circulation.—The good effect of the introduction of fluid is in no way limited to cases of actual loss of blood by hæmorrhage, although in them it may be best marked. In all cases of shock the introduction of fluid is of at any rate temporary service. This is most easily accomplished by injecting 2 pints of water at blood heat into the rectum, repeating the dose after a quarter of an hour. Much of the water is quickly absorbed. The infusion into a vein of 4 to 6 pints is subject to a longer preliminary delay, but when everything is ready to hand, and the case a severe one, the infusion into a vein has a superiority over rectal enemata.

The general treatment for all forms of collapse consists in wrapping up the patient until the skin of the extremities becomes warm and sweat is secreted. Hot-water bottles are placed between the blankets, not in contact with the patient, or superficial burns may occur. The extremities may be first rubbed. Each limb may be wrapped up separately. Hot fluids—water, milk, beef essence—are given by the mouth in teaspoonfuls, or by the rectum in enemas of 3 ounces each, repeated every hour or two.

Alcohol diluted by hot water is added, as it aids the return of warmth. One ounce of brandy spread over two hours is about the largest amount which should be given, and often very much less; beyond this the alcohol narcotizes the patient. To give anything more than a sip or two before wrapping up the patient is to increase the loss of heat. Excess of alcohol is most injurious whenever there is failure of respiration; hot coffee is much better. When the temperature falls below 97° F., the prognosis as to recovery is very unfavourable. If any operation is meanwhile performed, the patient is almost certain to die.

Fainting is met by giving cold water to drink, lowering the head between the knees, opening the window, loosening the clothing, exciting the nose with a feather, with ammonia, eau-de-Cologne, vinegar, ether, or nitrite of amyl. In severer cases dilute ammonia may be injected subcutaneously.

Injections of alcohol, ether and strychnine often do more harm than good. In anything more than small amounts, alcohol and ether anæsthetize and add to the shock. Strychnine, except in small doses, will hinder respiration by exciting rigidity of expiratory muscles.

The application of the faradic current is useless, or even harmful. Either precious time is wasted, or pain is caused to a patient who needs rest. Supposing a current strong enough to reach the heart, the effect would be slowing or temporary arrest.

The General Treatment of Accidents.

These may occur singly, and thus obtain the surgeon's undivided attention, but a catastrophe may suddenly throw a number of wounded of all kinds upon the hands of a single surgeon.

The first aid to the wounded consists in: (1) Checking hæmorrhage; (2) restoring respiration; (3) fixing fractures; (4) supplying water to all, and alcohol to a few; (5) devising some means of transport.

1. Blood flowing from a limb is checked by a handkerchief, braces, or any other kind of band, surrounding the limb above the bleeding-point, with additional pressure below, or on the wound if venous blood continues to flow. The band is tightened by twisting it up with a stick. Bleeding from the head, neck, or trunk, must be checked by direct pressure.

2. If breathing be difficult, the finger is thrust as far into

the pharynx as possible in the search for foreign bodies, and artificial respiration practised whilst the heart continues to beat. The trachea is opened when air does not enter.

3. If the arm be fractured, it is placed in position across the chest, and the coat buttoned over it; if one leg be fractured, it is tied to the other; if both, they are tied to any bar long enough to be fixed to the trunk.

4. The invariable desire of anyone injured, and more especially when blood is lost, is for water. It is a great mistake to give alcohol freely, especially to a half-drowned man, for it tends to dilate the vessels of the abdomen and skin, and by so much to deprive the heart and brain of blood.

5. A person injured in the head, neck, or arm, may be supported by placing the shoulder in his arm-pit, with his sound arm round the neck. One injured in the leg may be carried on the back, or by two joining the hands to form a chair. A fracture of the spine should not be moved at all until a plank or hurdle or gate can be obtained, which should then be slipped under him with as little disturbance as possible.

Wounds should not be touched, chiefly because of the inevitable inoculation from the hands, and, secondly, for fear of causing further hæmorrhage by disturbing the clot. The wound should be left untouched and exposed to the air, so that the blood-clot may dry as quickly as possible and form the best temporary protection. If there is so much bleeding that pressure is necessary, the cleanest material available is applied without contact by the hand.

The duty of a surgeon in face of a number of accidents is to divide them into three classes: (1) Those about to die; (2) those capable of being transported to a hospital for treatment; (3) those but slightly injured.

1. In the case of those so severely injured that death seems imminent, any attempt to transport them will cause needless pain, and they will probably die on the road. Such patients should be laid as comfortably as possible, given morphine injections, alcohol, or liquid food, and be troubled as little as can be. At any rate, an opportunity is thus given for a possible rally.

2. In the second list will be those who can bear a journey

to a place where they can be treated on ordinary lines. It is utterly useless to do surgical operations in a rough fashion. Fingering of wounds, searching for bullets, amputations, trephinings, fixing compound fractures, searching for bleeding vessels, cleaning of large wounds, cannot be properly done except in a place prepared for surgical purposes. If attempted in the open or in a shed or barn, an enormous mortality is inevitable. Tracheotomy, injections of fluid into the rectum, tying in catheters, applying clamp forceps to bleeding-points, are the operations that should alone be attempted until the patient has reached a place where antiseptic methods can be carried out. Of course there are exceptions, as, for instance, when a patient can only be freed by amputation of a limb which has been crushed and firmly caught in wreckage.

3. In the case of those slightly wounded there is the same danger from septic infection, from dirty fingers or instruments, and the possibility of even a fatal result if a small wound be attacked by erysipelas. Even the smallest wound should not be dressed until it can be done with all antiseptic care.

Accidental Hæmorrhage causing Acute Anæmia.

When a healthy dog is anæsthetized, and half the total amount of blood allowed to escape from the carotid, hardly any more will flow, the heart will beat feebly, and the respiration be shallow and slow. If the vessel be then tied and the dog left to itself, the animal will soon die. If, however, before ligaturing the vessel an amount of normal saline solution (0·75 per cent., *i.e.*, a full teaspoonful to a pint), at least equal in volume to the quantity of blood lost, be injected, the dog will in a day or two be well again.

From acute hæmorrhage a patient's extremities become pale, unconsciousness supervenes, the pulse is felt feebly or not at all at the wrist, the heart impulse and sounds diminish until they can be hardly heard; the respirations are slow, shallow, and sighing. Acute anæmia arises not only from wounding, but also during labour, and from the rupture of varicose veins in the leg. The patient is laid horizontal, or the head is kept lower than the body, and the extremities are raised. The elevation of the limb is sufficient to check bleeding from a venous trunk; an artery may be clamped, or pressure applied above or to the wound. When the bleeding has stopped, 2 pints of warm water must be injected into the rectum, and preparations made to infuse saline fluid into the vein at the elbow. From 2 to 6 pints are injected, until the pulse is felt plainly at the wrist, the shrunken face filled out, some colour returned to the lips, and signs of recovery of consciousness appear. After this the extremities are bandaged, and warmth is restored by coverings and hot-water bottles, and the patient is urged to take abundance of fluid by the mouth. The patient may remain for months markedly anæmic, and require special treatment, such as iron, good food, and change of air.

Accidents from Cold.

Chilblains are small congested patches occurring on the fingers and toes of children, and of young people with feeble circulation. Venous congestion, thrombosis, inflammation, and ulceration, follow one another. They are prevented by improving the general health, and by wearing warm woollen gloves and socks, especially at night, by plenty of outdoor exercise, and by avoiding cold, wet feet, and hot fires. Iodine tincture relieves the itching, and hot fomentations the inflammation; mercurial ointments may be applied to the ulcers if healing is slow.

Frostbite happens in this country from sleeping out at night, and in persons who have a feeble circulation. The extremities—toes, fingers, tips of the ears, and less often the nose—are affected. If seen early, the circulation is restored by gentle rubbing, not by applying heat; afterwards the part is wrapped in cotton-wool. If dry gangrene has already set in, it is wrapped in wool, dusted with iodoform, and opium tincture is given. In cold countries special care is taken to avoid frostbite, and it is there generally due to excessive indulgence in alcohol. A person collapsed from cold must not be exposed to sudden heat; friction with snow, ice, or cold water should be first used, especially on the extremities; warm liquid food with but little alcohol is given in small quantities and at frequent intervals, either by the mouth or rectum.

Insolation or Sunstroke.

This is the effect of the sun upon the head and spine, producing dilatation of cerebral and spinal vessels. It is aggravated especially by the fatigue of muscular exertion under a hot sun, and by want of food and water in young soldiers unaccustomed to the climate. Hence its prevention by a thick covering to the head and spine, especially in the cervical region, the avoidance of the mid-day tropical sun, a supply of food and water carried on the journey, and gradual acclimatization. Liability to malaria intensifies the danger of sunstroke. The special treatment is the application of ice to the head and spine, liquid food, and rest. The subcutaneous injection of ether, artificial respiration, and flagellations are the best treatment for the dangerous coma.

Burns and Scalds.

Burns are of various degrees of severity: (1) Superficial scorching followed by vesication, not extending through the skin, and therefore not followed by scars; (2) the whole thickness of the skin is involved, and, after the separation of the eschar, healing takes place by scarring and contracture, which must be prevented by skin-grafting; (3) the burn involves the body or a limb, extending deeply to muscle and bone. Burns of the third degree are, of course, immediately fatal unless limited to one extremity. Probably the death is not attended by prolonged pain owing to the anæsthetic effect of the carbonic oxide and carbonic acid gases. Burns of the first and second degree are dangerous according to their extent, death being due to the shock.

Complications.—The fatal complications of burns arising from septic absorption may produce a 'typhoid' condition, and sometimes duodenal ulceration and hæmorrhage, or death ensues from tetanus. These complications can be prevented by antiseptic treatment. Other remote local complications of burns, arterial, venous, and lymphatic obstruction, immobilization of joints, and other deformities, are owing to the contraction of the scar, the chronic inflammation and ulceration of which may lead to keloid and epithelioma. These local complications are prevented by skin-grafting.

Putting out the Fire.—A person whose clothes are alight must be prevented from running about, and should, if possible, be rolled on the ground whilst wrapped up in the thickest stuff at hand. The burning clothes must not be plucked away, as patches of skin may thus be torn off.

Primary Treatment.—The first duty of the surgeon is to relieve pain by giving a hypodermic injection of morphine to an adult, and a few whiffs of chloroform to a child. The next thing is to administer fluid food, enemata, alcohol, and to cover the patient warmly. The patient should not be disturbed by any attempt at dressing until some recovery from shock has taken place. He will then be the better able to bear the first dressing, and may the more safely be anæsthetized. Moreover, by the delay, the blunder of needlessly troubling a dying patient is avoided. The clothes are cut away after being well soaked; a child may be put into a bath. The removal requires great gentleness, and it is better to leave a fragment of the clothes adhering than to pull off the skin or eschar, and set up hæmorrhage.

Dressing of Burns.—A scorched surface should not be washed, for water causes much smarting, and antiseptics like carbolic acid or perchloride are easily absorbed. The surface is dusted thickly with boric acid and oxide of zinc powder; it may be painted with nitrate of silver to produce a protecting film. Lint or gauze may be applied wrung out of a saturated solution of picric acid (picric acid 5, absolute alcohol 80, water to 1,000). Either dressing need not be changed for several days.

Vesicles are simply punctured and covered with the boric acid and zinc powder, or the saturated picric acid gauze. It is the contact with air and water which causes so much pain. If in the later stages the dressings stick, carron-oil (linseed-oil and lime-water with a little turpentine), vaseline, or boric acid and zinc ointment is applied.

Burns of the second and third degrees are covered with iodoform powder and antiseptic gauze. Washing and wiping should be done at first with carron-oil, not with water. As soon as a piece of skin is noted to be dead, it is raised, and a gentle stream of permanganate lotion is introduced to wash away pus and débris. Then a strip of iodoform gauze is slipped underneath. Sloughs are cut away piecemeal. Doubtful skin is also raised by slipping gauze beneath, so that its discharges are not absorbed by the subjacent tissues, and any which is inclined to live is favourably placed between the gauze beneath and the main dressing over it.

Grafting.—As soon as healthy granulations have appeared, epidermal grafts are applied, so that scarring and contracture are avoided.

Amputation.—Where an arm or leg has been so badly burnt that amputation is required to produce a sound stump, it is carried out after the patient has recovered from the shock of the accident, and before exhaustion has set in.

Electric and Lightning Discharges, short of proving immediately fatal, cause burns along with a great deal of shock. If the injured person is lying in contact with the electric apparatus, the current must be shut off by some person who understands how to do it. If this cannot be done, he must not be touched with the naked hand; india-rubber gloves must be put on, or the coat, if dry, is taken off, folded, and the injured person's clothing grasped through it. In order to break the current, the body must be withdrawn from the wire, or, if entangled, lifted from the ground and a dry cloth interposed. The first treatment is directed to the relief of shock; afterwards the burns are dressed.

Recovery from Drowning.

If a man can be got out of the water within four minutes, he may be generally brought round. Occasionally submersion for a much longer time has ended in recovery, which must always be presumed to be possible—at any rate, for half an hour. First the mouth is forced open—*e.g.*, by a stick—and everything cleared out with the finger. Next, the patient's head being low, and his face downwards, the body is raised, and forcible expression is made on his chest and abdomen to drive water, etc., out of the air-passages. This must be done before artificial respiration is commenced. Then the elbows of the patient are seized, thrust forcibly into the side, and slid forwards on the chest till they meet, thus pressing on the epigastrium and sternum; then they are raised so as to meet behind the head, thus expanding the thorax by putting the pectoral muscles to the fullest stretch. As soon as natural respiration has begun, the application of warmth, a hot bath, mustard plasters to the chest and calves, the administration of hot water and coffee follow.

Recovery from Carbonic Oxide and Carbonic Acid Poisoning.

Artificial respiration is required in the first place, and wherever pure air cannot be got—*e.g.*, in a mine—a tube is connected from an oxygen bottle to the patient's mouth, and the gas allowed to pass in as the chest is enlarged.

Adjuvants to artificial respiration are: Ammonia inhalations, tickling the throat to produce vomiting, slapping the chest, hot fomentations and plasters to the extremities, nutrient enemas, but not alcohol.

Punctured Wounds—Bullet Wounds.

An uncomplicated punctured wound is treated by cleansing the skin and applying an antiseptic dressing. The patient is kept at rest until healing has taken place.

Punctured wounds are complicated (1) by the introduction of septic matter adhering to the puncturing instrument; (2) by the entrance of a foreign body, which lodges in the wound, not only carrying in septic material. but acting as a mechanical irritant; (3) by the injury done to deeper parts, which is more or less concealed.

A bullet wound is a punctured wound, further complicated by the shattering, explosive effect on all the tissues beneath the skin, owing to the high velocity with which a bullet from a modern rifle enters. The skin is so elastic that it stretches before the bullet, and closes, leaving a minute puncture or merely a small punched-out hole. Underneath the skin the bullet drives the semi-fluid muscles before it to the side, causing extensive laceration and bruising. It cuts a hole clean through bloodvessels, so that they bleed freely. On contact with bone the splinters are driven in all directions, so that a short bone is smashed to fine pieces at the point of contact, and fissures radiate widely in the skull or in the shaft of a long bone. On penetrating the skull—and this may happen at a distance of nearly 3,000 yards—the bullet acts explosively on the brain, as may be shown by firing into a closed vessel containing a semi-fluid material. The vessel bursts like a shell. Thus, the skull and brain may be reduced to a pulp beneath the practically intact scalp.

Spent rifle and pistol bullets of low velocity are more favourable for surgical treatment, owing to the damage being limited to the actual track of the bullet.

A punctured wound requires special treatment on account of hæmorrhage flowing from the wound, or extravasated into a cavity, or causing an aneurysm. Practically, all the deaths on the battle-field from bullet wounds are due to primary hæmorrhage, except those involving the brain and upper part of the spinal cord, in which, however, the primary hæmorrhage is an important factor in causing death.

The treatment of the primary hæmorrhage will vary according to the position, whether the skull, thorax, or abdomen is involved, or whether the injured vessel is in the neck or one of the limbs. The punctured wound may be enlarged, and the track of the bullet followed, or the injured vessel is cut down upon directly, so as to arrive at it just above the point of injury. Small vessels are closed by plugging with gauze.

Foreign bodies, bullets, and splinters of bone are found and extracted by enlarging the punctured wound. Bullets are difficult to detect and to extract. A bullet can be detected by striking it with a probe, and especially by touching it with a probe forming one electrode of an electric circuit, the other electrode being in contact with the patient's skin. As an indicator, a microphone may be used (Pratt's electro probe), or a galvanometer when there is no need to carry the apparatus about. The bullet may not, however, be detected, owing to the probe not coming in actual contact with it. The bullet may be then shown by the X-rays, its position being judged by viewing it from more than one point. An exploration may be made through a sufficient wound after studying the position of the patient at the time of the injury, and after taking note, especially in a late case, of the sensations of the patient.

The forceps for extracting a modern bullet resemble dressing forceps or a volsella ; they have to pass along a narrow track and seize the bullet firmly, without grasping muscle or aponeurosis.

Splinters of bone, when completely separated, are removed ; others are replaced, and fixed in position.

No foreign body should be extracted unless the surgeon is prepared to arrest the hæmorrhage which may follow.

A punctured wound which has been infected must be completely antisepticized, and afterwards filled with gauze. This is specially necessary when a cavity has been opened, such as the knee-joint. After the first dressing, a small strip of gauze is reintroduced to serve as a drain.

When septic inflammation and suppuration have already commenced, the punctured wound is treated like a suppurating sinus. It is enlarged, all pus and septic granulations are scraped away, and the whole interior freely treated with an antiseptic.

Lacerated Wounds.

A lacerated wound is characterized by a tearing rather than a cutting through of the tissues. There is comparatively little hæmorrhage, owing to the torn edges of the bloodvessels turning inwards, whilst the proximal end of the artery itself retracts into its sheath. Blood-clot quickly closes the lumen even of such a large vessel as the femoral. A lacerated wound has, however, many tags of tissue, which slough, owing to insufficient blood-supply ; and many pockets, in which pus may collect.

A lacerated wound is always infected by pyogenic organisms. It must be, therefore, treated with 5 per cent. carbolic acid, including all the pockets. It will also be wise to ligature any large artery which may be torn, and any in which the washing starts hæmorrhage.

A lacerated wound is not usually suitable for the application of a suture, owing to the bruising of the parts around, the exceptions being on the skull and face, in which the blood-supply is excessively good ; and these should always be sutured, however much laceration there may be. In other cases the wound is left open, dressed with iodoform gauze daily, and when healthy granulations have formed, the wound may be skin-grafted or drawn together by strapping.

Poisoned Wounds.

Pyogenic Organisms are usually staphylococci, causing suppuration. The prevention and treatment of this infection has already been described.

Erysipelas and other forms of Acute Œdema are due to streptococci, mixed later with staphylococci. The infection is transferred from a case of the same kind, or by hands not disinfected after contact with discharges from a case of puerperal fever, purulent peritonitis, scarlatinal or diphtheritic suppuration. The special signs are the rapid onset of an acute fever, accompanied by local redness of the skin from capillary dilatation, an œdema of the wound-edges with a thin discharge, an extension of the redness and œdema along the lymphatics to the neighbouring lymphatic glands.

The local treatment consists in thorough antiseptic measures to the wound. Multiple punctures, into which 5 per cent. carbolic acid is rubbed, not only reach the organisms, but relieve tension, and so limit the subsequent suppuration. The œdema and swollen glands are treated by hot fomentations and the application of belladonna extract.

If the fever continues in spite of local treatment, and the patient tends to become delirious owing to general absorption, further measures are necessary. Streptococcus antitoxin is administered. The swollen glands are excised, and the cavity filled with gauze. The limb may have to be amputated.

Phagedena is an infection of the surface of a wound producing a rapid superficial ulceration and fever from absorption of chemical substances. It is caused by keeping a wound moist, hot, and in contact with its decomposing discharges, by applying simple water-dressings, *i.e.*, by putting a rag wetted with water over the wound and wrapping it up. Epidemics used to occur by transference from one case to another, especially in military hospitals. Before the days of antiseptic surgery, phagedena was never long absent even from the best hospitals. It is now only seen in cases where all surgical treatment has been neglected. The wound is covered with a greenish slime, from which there is a thin discharge, and the edges appear as if they were melting away. The ulcer is painted over with pure carbolic acid, which is then washed off and the surface dusted with iodoform; or scraping and rubbing in the antiseptic may be done under nitrous oxide gas.

Maggots in Wounds.—Before the discovery of antiseptics, wounds became fly-blown even under the surgeon's care, and there are living those who remember to have seen them. As with phagedena, they can only occur from utter neglect, and are killed by any antiseptic.

Tetanus.—Tetanus is due to a bacillus which grows and produces its poison at the site of inoculation. The infection is especially likely to happen in a lacerated wound if garden or road earth contaminated with dung is inoculated at the same time, also when a rusty nail causes a punctured wound of the foot, for the bacillus lives in garden-mould and in stable-manure. Epidemics used to occur, especially in war-time, and tetanus is still common among the negro infants in the West Indies. The first definite sign of tetanus is stiffness, going on to rigidity, of the lower jaw. The preceding fever and lassitude have nothing diagnostic about them. Following that of the lower jaw comes on contraction of the angle of the mouth (risus sardonicus), contraction of the limbs, bending of the spine backwards till the patient rests on his head and heels (opisthotonos), or bending forwards (emprosthotonos), or to one side (pleurosthotonos). Moreover, there is spasm of the muscles preventing swallowing, and, in the later stages, spasm of the larynx obstructing respiration. The spasms at first intermit, then become more and more constant, whilst the patient gets weaker from pain and want of food.

Tetanus is generally fatal in infants when due to inoculation at the umbilicus. If the symptoms appear in a strong adult within a day or two of the injury, the disease usually runs a rapid and fatal course.

If the symptoms appear a week or more after the inoculation, increase but slowly, and the patient has been previously in good health, recovery may ensue. Cases in which the symptoms appear after a fortnight or three weeks usually recover.

Tetanus is prevented by the careful treatment of the primary wound. Immediately the symptoms appear the wound is cut out freely, and the surrounding tissues injected with a few drops of 5 per cent. carbolic acid. Supposing the symptoms are not at once relieved by this measure, amputation should be done without hesitation.

Tetanus antitoxin has not yet been successful in arresting the acute forms of the disease which come on soon after the injury. But improvement owing to further experimental observations may be confidently anticipated. Success has followed the use of antitoxin in more chronic cases, but whether it really aids the natural resistance of the patient is still doubtful. The general treatment consists in feeding the patient, artificially if need be, whilst the spasms are relieved by chloral, opium, or chloroform vapour, administered in small and repeated doses.

Hydrophobia.—This is inoculated by the bite of a rabid dog, cat, or other animal. It is of the utmost importance that the dog should not be immediately killed, but be placed under observation in a strong cage, through which food and water can be passed. If rabid, the bark is first altered, then lost; there is difficulty in swallowing, and the hind-limbs become paralyzed. After death hæmorrhages will be found in the mucous coat of the stomach, and a glycerin emulsion of the bulb injected under the dura mater of a rabbit will cause this animal to die in eighteen to twenty-one days, after suffering from paralysis of the hind-limbs, then of the fore-limbs, and finally of respiration. A suspected wound is well scrubbed out with carbolic acid, and when the existence of rabies in the animal causing the bite has been demonstrated, the patient must immediately submit to the course of antitoxin administration prescribed by M. Pasteur.

Anthrax.—Anthrax is inoculated, especially on the face or neck, also on the hand or forearm. Those who handle foreign wool and hides are liable, and also those engaged in making post-mortem examination and burying diseased animals. The disease can be transferred by large meat-flies. Volkmann recorded a case in which the disease was inoculated through a catgut ligature made from the gut of a diseased sheep. An acute dusky-red œdematous swelling of the skin spreads from the point of inoculation, which becomes a black eschar surrounded by a ring of vesicles. The diagnosis is made by examining the pus under the eschar, and a drop of blood from the œdematous zone. The anthrax bacilli are large rods, and are therefore easily distinguished from the micrococci found in a case of acute ecthyma. The anthrax pustule must be cut out, and 5 per cent. carbolic acid injected and rubbed into punctures made in the surrounding œdematous zone.

Diphtheria.—Diphtheria is generally inoculated through the throat or nose. It is now rare to see a diphtheritic membrane covering a wound, unless it is the tracheotomy wound, made when the disease is already present in the larynx. Chance inoculations may occur; *e.g.*, a house surgeon was doing a circumcision, when his nose began to bleed, and a drop of blood fell on the wound. The next day the child had a thick membrane covering the wound, and the house surgeon was ill with a severe attack of naso-pharyngeal diphtheria.

The diphtheritic membrane is easily cleared off a wound by rubbing with pure carbolic acid, washing and dusting with iodoform. If noted early, no general symptoms need be expected. If, however, the membrane has remained a day or so, it may be best to administer the antitoxin.

Syphilis.—The index-finger is liable to be inoculated with syphilis during vaginal examination. A little ulcer appears to one side of the nail, or at the spot where a tag of epidermis has been torn off. A bite or wound of the knuckle from contact with a tooth may also introduce syphilis. There is no marked induration in the case of a syphilitic sore on the hand, and the diagnosis is determined by the enlarged glands and the appearance of the rash. A good course of mercury may be expected to prevent any further secondaries, and to do away with the fear of later tertiary affections.

Circumcision wounds have been infected by the saliva from the mouth of Jews suffering from syphilis.

Some cases of syphilitic infection occurred in the early days of vaccination, but this danger is now excluded by the use of calf-lymph.

Vaccination.—Vaccination is sometimes unintentional. The mother kisses the arm of the child, and gets a pustule on the lips; or the arm of the child rubs her breast, and causes a pustule. A fragment of a lymph-tube has spurted up and inoculated the conjunctiva of the vaccinator. The pustules are the same as in ordinary vaccination, and tend to disappear after the eighth day, as also do the enlarged glands. In addition there is the history of the baby being vaccinated, and the absence of all evidence as to syphilis.

Ordinary vaccination wounds of the arm, if not attended to, become the seat of eczema, ulceration, erysipelas, phagedenic sloughing.

Tubercle.—Tubercle is very rarely inoculated. Cases have occurred to children circumcised by Jews suffering from pulmonary phthisis.

Anatomical warts are local forms of tubercle, which either disappear of themselves or do so on the application of caustic.

Arrow Poisons.—Some owe their virulence to septic matters. Curara causes muscular paralysis, and is fatal owing to failure of the respiratory muscles. A case is reported to have been restored after two hours' artificial respiration.

Snake-bites.—The poison of snakes is a soluble product of albumin which is rapidly absorbed. The bite of the viper on the hand causes rapid swelling of the arm, which pulsates forcibly, and into which blood becomes extravasated. Meanwhile the patient suffers from terror, nausea, vomiting, collapse. A band should be tied round the limb above the bite, tight enough to check absorption through the lymphatics and veins. Gunpowder is rubbed into the wound and set fire to, or the wound is cauterized by the burning end of a match. Dilute ammonia is injected into and around the wound ; the patient is stimulated by hot coffee or a little alcohol, and kept moving, as in opium-poisoning. If the stage of collapse is reached, vigorous treatment is required, in order to restore respiration and warmth.

Wasp-stings.—Wasp-stings are occasionally fatal by causing sudden failure of the heart, or acute œdema, which reaches the glottis and obstructs respiration. Stings about the face and neck and in the mouth are specially dangerous.

CHAPTER IV.

PUNCTURE—INCISION—ERASION—EXCISION.

Puncture.

WHEN a grooved needle is pushed into normal tissue or into a solid tumour, only blood escapes. If the needle enters a cavity containing serous fluid or thin pus, a little will ooze out along the needle. If the pus is thick it will not flow; but some is found in the groove when the needle is withdrawn, and a trace may be discovered by washing the needle with a drop of water, and examining the washings under the microscope. A trocar and cannula are employed, in order that fluid may escape through the cannula on the withdrawal of the trocar. It is important to note that the trocar is sharp, and that the cannula fits it closely; then plunge it in quickly, fixing the depth it should go by the forefinger on the shaft. A negative result is not conclusive, for the trocar may push tissue, such as the wall of an abscess, in front of it without piercing the wall; or the trocar gets fixed in a partition wall, or in a piece of fibrin or slough; or, finally, the pus is too thick to run off. These difficulties are partly overcome by moving the point freely, so as to find whether it is in a cavity, and also by passing a stylet down the cannula or by syringing in a little water, in order to clear a way out.

Aspiration.—A fine long needle is attached to a syringe, and so fluid can be withdrawn for diagnostic purposes.

Large cavities are emptied by having a trocar and cannula attached to a bottle in which a vacuum can be made by an exhausting syringe. It is especially used for the pleura. Aspiration is unsuitable for emptying collections of fluid in the abdomen, for on the withdrawal of the cannula fluid is apt to leak into the peritoneum and infect it.

Multiple Punctures with a fine knife are sometimes made to relieve the congestion of the skin in erysipelas, and to allow of the rubbing in of an antiseptic. Multiple punctures by the scarificator are occasionally employed in wet cupping as a counter-irritant.

Acupuncture.—Indian practitioners are said to still pass fine steel needles with a rotatory movement into the liver and elsewhere for the relief of pain. The boring into bone at a painful spot with an awl is of service where there are not sufficient indications for cutting down upon the bone.

Injections.

Injections are employed for the introduction of medicinal agents into the subcutaneous tissue, muscles, cysts, and joints by means of syringes and hollow needles. It is essential that the syringe, needle, and fluid injection should be aseptic. The syringe and needle are repeatedly washed out with 5 per cent. carbolic acid, and finally with absolute alcohol before and after use. A piece of silver wire is kept in the hollow needles to prevent rust. Some syringes can be boiled in a soda solution.

Subcutaneous Injection is used in order to introduce many drugs—morphine to relieve pain and give sleep; strychnine, dilute ammonia, alcohol, or ether, as temporary stimulants; cocain as a local anæsthetic. None of these substances should cause pain or excite an abscess. Ergotine to check hæmorrhage, and mercurial salts for their rapid influence on syphilis, must not be introduced subcutaneously on account of the pain caused and the liability to abscess. Antitoxins are injected, *e.g.*, for diphtheria, tetanus, tubercle, into the subcutaneous tissue. Water has been injected for collapse, but the method appears inferior to rectal enemata and venous infusion. Turpentine injected subcutaneously causes an abscess, and is an ancient method of treating acute fever, *e.g.*, pneumonia, by making a 'fontanelle.'

Intramuscular Injections.—Ergotine is injected into the buttock to restrain hæmorrhage, *e.g.*, from the uterus, but more direct methods are best. Mercury salts have been introduced into muscles; but except for some severe and rapidly extending tertiary forms it is not advisable, as much pain is generally caused, and sometimes an abscess in spite of all antiseptic precautions.

Injections into Cysts and Joints.—Iodine is used for a ganglion, thyroid cyst, hydrocele, meningocele, etc. It rarely cures, often doing no good at all, time is wasted, and the patient put to pain for nothing. Sometimes it starts suppuration, and so gives rise to dangerous complications. A 10 per cent. solution of chloride of zinc is used for chronic hydrarthrosis or early tubercular disease, also for recurrent dislocation of a joint, and in order to close a hernial ring. Iodoform emulsion is injected without, but much better after, removing the contents of a tubercular abscess or joint.

For injections into veins, see p. 79.

Incisions.

Incisions as made by the surgeon are linear, angular, or semicircular. In the last two the skin is raised as a flap; in the first case it is merely retracted. The line is usually guided by the eye alone, but marks on the skin may be made beforehand with an anilin pencil or a stick of nitrate of silver. The knife is held in the hollow of the hand like a violin bow for light strokes, and like a dinner knife when more force is used. The index-finger rests on the back except in the case of a long amputating knife, which is grasped. The knife is stuck vertically into the skin at one end of the incision, so as to enter the subcutaneous tissue, or even to reach muscle; then it is sloped to an angle of forty-five degrees, and drawn steadily, without sawing, to the end of the incision, at right angles to the plane of the skin; there the incision is ended by bringing the handle of the knife to the vertical position with which the incision started. If the skin is not tense, it is made so between the thumb and fingers of the left hand, or between the left hand and that of the assistant. If the structures beneath present an uncertain resistance, *e.g.*, in hernia, the skin is pinched up and transfixed.

Retractors, or hooks of various kinds, are used to separate the edges of the wound, and to render tense deeper tissues.

Anatomy forceps are not used in straightforward incisions, only when drawing near to an important structure. The surgeon may use anatomy forceps as in ordinary dissection, or the layer to be divided is raised between two pairs, one held by the assistant; the surgeon can then cut between the forceps without any danger of wounding subjacent structures. Two pairs of anatomy forceps may be used for tearing through thin tissues.

Directors are only of use for the tracking out and laying open of sinuses.

Scissors cut just as cleanly as a knife, and may be used whenever the finger can be passed to guard the under blade.

Incision of Abscesses.—In order to obtain rapid healing, it is necessary to open an abscess by a free incision, so that there shall be no longer any retention of pus, and to do this at the earliest possible moment. A small incision into the centre, where pus has hardly yet formed, will quickly relieve tension and prevent the extensive destruction of tissue.

Suppuration and the formation of an abscess is inferred from the severity of the general and local inflammation, also from the presence of fluid; the latter is the only sign of a cold abscess. The presence of fluid is indicated when fluctuation—*i.e.*, the displacement of the fluid when the tumour is alternately pressed upon by two fingers—is obtained. But fluctuation is not perceptible when the fluid is under tension or the wall comparatively thick. A fatty tumour gives a similar sensation, but is lobulated, puckers the skin, and its edge can be displaced. Muscle gives a sensation of fluctuation transversely, but not longitudinally. The diagnosis is confirmed by an exploratory puncture.

A superficial abscess can be incised by freezing the surface, then quickly puncturing and cutting outwards. The hand should rest on the patient, lest any movement on his part make the puncture too deep.

Deep abscesses are opened under general anæsthesia, by cutting into the subcutaneous tissue, then pushing dressing forceps or clamp forceps through the soft wall into the cavity, and dilating the aperture by opening the forceps. Pus is washed out, the cavity wiped out with pledgets of wool, or the wall may require to be scraped. Iodoform and a strip of gauze are inserted, and changed daily, or oftener.

If the cavity is a large one, it is explored by the finger, and a counter-opening may be made by cutting down upon the end of a probe or clamp forceps. A drainage-tube is then passed through. The cavity is washed out once or twice a day through the tube, and iodoform emulsion can be injected. The pus quickly becomes thinner, and small in quantity, and this is a sign that the tube may be removed.

When there is much inflammatory induration, hot boric acid fomentations are applied, the cavity being washed out when the fomentations are renewed.

Erasion, Scraping, Curetting.

Erasion, or scraping, or curetting, is employed to hasten the removal of diseased and dead tissues, which otherwise take some time to separate, and meanwhile poison the surrounding healthy cells. It is also required in order to reach the micro-organisms infiltrating the tissues, so that strong antiseptics may come in contact with them and destroy them.

Scraping is done with a sharp spoon, combined with washing and wiping, until healthy tissue is reached. It is also combined with the cutting away of tough material by the knife or scissors, and by the gouging of bone.

In treating sinuses, as much as possible of the tough wall is cut away, and the rest scraped.

Scraping has to be done with gentleness when there is a large abscess cavity with a very vascular wall, or when a large vein or artery is involved in the abscess wall, or when the wall is of friable tissue, easily perforated, like the uterus.

If the diseased surface is a limited one, a strong antiseptic may be applied, like pure carbolic acid ; if more extensive, only 5 per cent. carbolic acid is employed. In either case, the antiseptic is washed away directly. For very large cavities, like a psoas abscess, or surfaces from which absorption is easy, like the knee-joint, iodoform is the only suitable antiseptic, on account of its slow solubility.

Excision.

Excision implies the complete removal of the disease by the division of healthy tissue lying beyond the disease. The operation varies according as the diseased tissue, or tumour, is attached to the healthy tissue by a peduncle, or is separated from it by a connective-tissue capsule, or infiltrates healthy tissue, so as to form no very exact line of separation.

Pedunculated Tumours.—These tumours are free except for the pedicle which contains the bloodvessels; the important part of the operation, therefore, lies in arresting hæmorrhage. A polypoid mass on the surface may be snipped off, and the bleeding afterwards stopped, or small polypi in the nose or elsewhere can be surrounded by a galvano-cautery snare, which is first tightened, and then the wire is heated to a dull red, so that the hæmorrhage is arrested as the wire cuts through. In more important and vascular tumours the operation is so carried out that the pedicle is reached and tightly ligatured before the tumour is cut away.

Encapsuled Tumours. — Cystic or solid tumours are separated from healthy tissues by a capsule of inflammatory connective tissue. A parasitic hydatid cyst is so slightly attached in its earlier stages to the adventitious inflammatory connective-tissue cyst around it that a separation can be made by a stream of water. A sebaceous cyst is also so slightly attached to the surrounding connective tissue that it can be easily 'shelled out.' The union between the cyst wall and the surrounding tissue becomes firmer by inflammation. Then the cyst has to be excised. This is easy, if the cyst wall is well defined. Benign tumours, especially fatty and fibrous tumours, are also readily separated. Although a tumour is encapsuled, large vessels may pass from the tumour to the capsule, and require ligature, as in the case of thyroid cysts and adenomata. A pedunculated tumour may also be encapsuled, as in the case of the kidney, the capsule of which is separated by the finger until the hilum is reached, where the vessels are tied. An ovarian tumour may be encapsuled, having burrowed into the broad ligament, or formed adhesions to neighbouring structures. After cutting through the capsule, separation is made by the fingers until the vessels are reached.

Infiltrating Tumours.—Malignant tumours infiltrate the tissues, as do also some forms of inflammation. There is no exact line of demarcation between diseased and healthy structures. It is therefore necessary to cut through healthy tissues well outside the border, in order to make a complete removal. This is done by long, sweeping cuts of the knife when there are no important structures in the way, and by very careful dissection when close to large vessels or other organs. A knowledge of the topographical anatomy of the part is absolutely necessary for rapid and safe division. The part to be excised must not be too strongly drawn upon, lest it stretch or tear, and some be thus left behind; moreover, if structures are displaced from their proper position, they are more likely to be accidentally wounded.

CHAPTER V.

THE SURGERY OF ARTERIES AND VEINS.

Wounds of Large Arteries.

THE rule is to tie a ligature tightly round the artery above and below the wound in it, and to divide the artery transversely. This allows the ligatured ends to retract within the sheath. It is wrong to place a ligature on an artery at some distance above a wound, for hæmorrhage will certainly recur from the distal end through anastomosing channels. For the application of ligatures the original wound must be enlarged to the required extent, bleeding being controlled meanwhile either by compressing the artery above or by making direct pressure with the finger in the wound. It may be right, however, in exceptional cases, when the ends of the wounded vessel have been so injured that it is doubtful whether the ligatures will hold, to ligate the vessel in continuity higher up in addition to tying the two ends, for thus the strain of the blood-tension will be taken off from the proximal wounded end.

Ligature of an Artery in Continuity.

The operation is so designed as to readily reach the artery by an incision which will allow the tissues superficial to the artery to fall again into position. It must avoid in particular the extensive division of muscles, which by retracting leave a large wound where blood-clot can collect. If division of muscles is absolutely necessary, they must be afterwards reunited. On exposing the sheath the pulsations of the artery will be felt. The sheath is opened over the artery, but rather to the side opposite to that on which is the vein, and the opening should not be more than ½ inch in length. The artery is carefully separated from its sheath, an aneurysm needle passed round the vessel, threaded and withdrawn. By gently drawing on the ligature before tying, it can be seen that nothing else is included. The artery is generally tied tightly by a surgeon's knot, the best ligature for an artery in continuity being kangaroo tendon; failing this, silk. As the first loop is tightened a resistance is felt to yield; this is the cutting through of the inner and middle coats (Fig. 27).

Methods less commonly used.—For ligaturing in continuity two other methods have been recommended. By the first a longer incision is made in the sheath, two ligatures are passed, and each is tied tightly about ½ inch from one another. The artery is then divided between, and each end retracts into the sheath, having on it a frill sufficient to prevent the slipping of the ligature. If this plan be adopted, particular care must be taken to tie the proximal ligature tight, and to have the ligatures sufficiently apart, so that they shall not slip when the artery is divided.

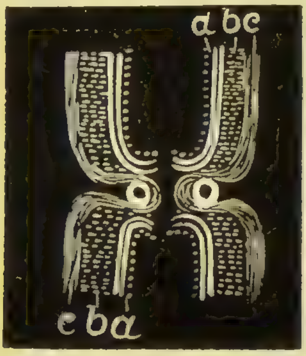


FIG. 27.—LIGATURE OF ARTERY.

When the ligature is drawn tight the inner and middle coats are divided, and the divided margins curl inwards *a*, Endothelium and elastic intima; *b*, media; *c*, externa; O, ligature.

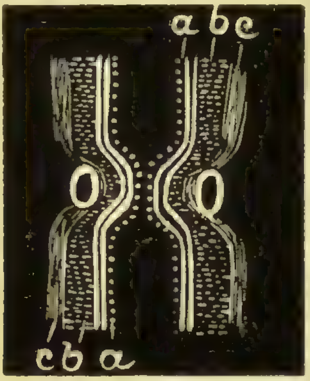


FIG. 28.—BROAD LIGATURE COMPRESSING ARTERY WITHOUT DIVIDING COATS.

a, Inner; *b*, middle; *c*, outer coat; O, ligature.

It has been proposed, on the other hand, to use a broad ligature, or two broad ligatures, *e.g.*, of gold-beater's skin, applied close together, and both tightened at the same time.

Each ligature is tightened only just sufficiently to stop the circulation (Fig. 28), but not enough to divide the inner and middle coats. The objection to this plan is that the circulation tends to be restored owing to the yielding of the ligature.

Artery Suture.—Experimentally and clinically it has been found possible to unite a small wound in a large healthy artery by fine silk sutures on a round needle passed through all the coats. Contrary to what might have been expected, neither the suture punctures bled, nor did secondary hæmorrhage occur, nor did an aneurysm form. This method may be applicable to a punctured wound of the common femoral or axillary artery, for by the ligature of the vessel the limb may be in danger of gangrene.

Recurrent Hæmorrhage.

This formerly occurred on account of the haste with which operations had to be concluded. Since the introduction of anæsthesia, the surgeon is able to arrest all hæmorrhage before closing the wound.

Bleeding may recur after an accidental wound, in which, owing to loss of blood, hæmorrhage has temporarily ceased. If the patient's history be indefinite, the surgeon has to watch for the recovery of vascular tension, when bleeding may begin again should a large artery have been wounded. He must then explore the wound and ligature the bleeding-point.

Secondary Hæmorrhage.

This is avoided in a clean-cut wound by the use of antiseptic ligatures. If the ligature has been applied in a wound already the seat of suppuration, the case has to be watched, and if secondary hæmorrhage threatens, the vessel should be ligatured in continuity at some distance above, and firm pressure kept up directly on the wound by gauze plugs and firm bandages. Secondary hæmorrhage may be inevitable from the artery being diseased by syphilis, tubercle, atheroma, or by extension of suppuration. Amputation, or ligation in continuity above combined with local pressure, is the treatment.

Aneurysms.

Surgical Aneurysm, when not traumatic in origin or subsequent to heart disease, generally occurs in those who have had syphilis. Alcohol in excess, by tending to cause arterial disease, predisposes to aneurysm. It has been conjectured abroad that the greater frequency of aneurysms in England is due to the excess of meat eaten. The essential lesion is a disease of the elastic coat, which yields whilst the rest of the coats stretch to form a bulging on one side of the artery (Figs. 29, 30). According to hydrodynamic law, every point of this dilatation is subjected to the same dilating influence of the blood-pressure as a point in the lumen of the artery itself. Thus, the total amount of pressure on the inner wall of the enlarging sac tends rapidly to increase. The endothelial lining at length fails to stretch over the inner wall, and the fibrous outer coat blends with the sheath of the vessel. The combined outer coat and sheath finally gives way, but if the leakage is at first slight, a new sac is formed by inflammatory thickening in the surrounding tissue. The aneurysm is now known as a secondary or consecutive

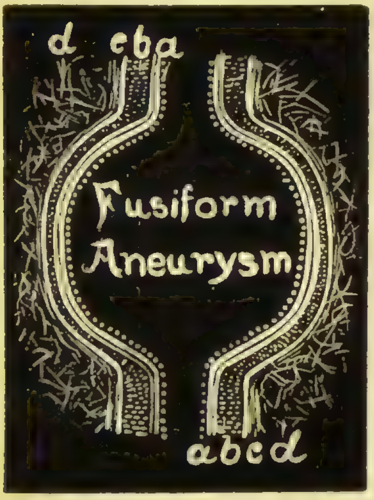


FIG. 29.—FUSIFORM ANEURYSM, BY STRETCHING OF ALL THREE COATS.

a, Inner coat of endothelium and elastic tissue; *b*, middle coat, muscle; *c*, outer coat, fibrous; *d*, connective-tissue sheath.

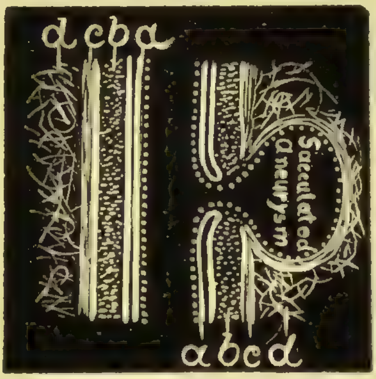


FIG. 30.—SACCULATED ANEURYSM.

The aneurysm is due to the yielding of the elastic and muscle coat; it is lined by stretched endothelium; its wall is formed by the outer coat and sheath.

one (Fig. 31). If the aneurysm bursts and blood flows rapidly into the surrounding tissues, infiltrating widely between planes of fascia and muscle, a diffuse aneurysm is formed.

The Signs of a Surgical Aneurysm.—A surgical aneurysm forms a swelling with an abnormal pulsation and sound.

The swelling decreases or increases according as pressure on the artery above is made or relaxed. The pulsation is distinguished as being in excess of that of the normal artery; the tumour which pulsates may be to one or other side of the artery, and if exactly over the middle, there is not only an antero-posterior impulse, as might occur from the artery being pushed forwards, but a lateral expansion of the swelling with each systole. A blowing sound is heard over the tumour even when it is not pressed on, and a rasping sensation may be experienced synchronous with the heart-beat, and stopped by compression of the artery on the proximal side.

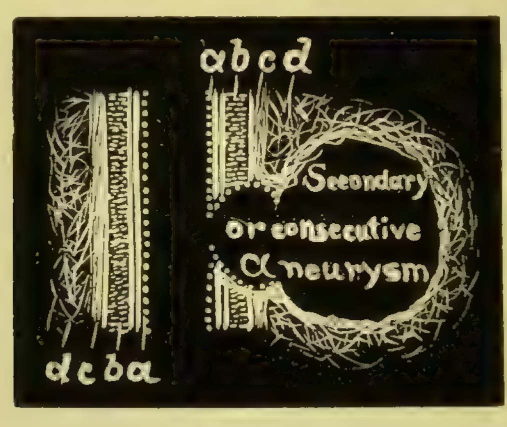


FIG. 31.—SECONDARY OR CONSECUTIVE ANEURYSM.

Endothelium and outer coat have yielded; wall now formed by connective tissue of sheath and surrounding tissues.

A diffuse aneurysm forms an ill-defined swelling or induration, with an indistinct pulsation and an abnormal bruit. It may be confounded with an abscess.

Arterio-venous Aneurysms.—A varicose aneurysm is one in which both artery and vein communicate with the aneurysmal sac (Fig. 32). The special signs are an enormous dilatation of the veins on the distal side of the vein involved, and the occurrence of pulsation in them.

An aneurysmal varix (Fig. 33) is a small leakage into a vein from a comparatively small artery, or by a minute hole from a large one. The characteristic signs are the absence of any aneurysmal tumour, and a loud noise like a humming-top, or like the buzzing of an insect in a box held close to the ear.

Direct Treatment of an Aneurysm.—It is necessary first to control the circulation above, and then to excise the aneurysm, or turn out the clot only and ligature the artery above and below. This is always required in a traumatic aneurysm; it is the only treatment likely to succeed for a septic aneurysm. An aneurysmal varix may be left alone so long as it does no harm. A varicose aneurysm must be operated upon as soon as possible, before the veins become much dilated; the proximal and distal ends of both artery and vein require ligature as well as the removal of the tumour and blood-clot.

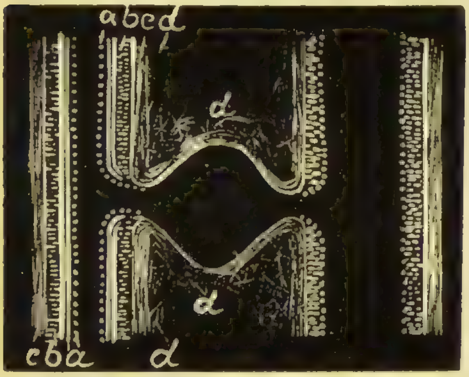


Fig. 32.—Varicose Aneurysm between Artery and Vein.
a, Inner coat; *b*, middle coat; *c*, outer coat; *d*, fibrous sheath of artery.

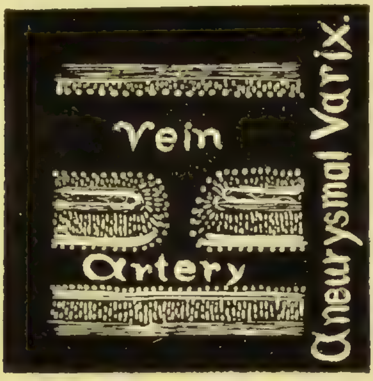


Fig. 33.—Aneurysmal Varix.

Proximal Ligature.—A sacculated aneurysm may be treated by ligature of the artery, the ligature being placed upon a healthy portion of the vessel some distance above the aneurysm. The aneurysm may then be cured by laminated clot filling the sac. If this method fails to obliterate the aneurysm, excision of the sac has to be done.

When an artery can be compressed so as to arrest the circulation for at least twelve hours at a time, the aneurysm may become filled by clot.

Distal Ligature.—Aneurysms in the root of the neck, which cannot be cured by ligature of the artery on the proximal side, have been treated by ligature of the blood-vessels leading from the sac, with the object of favouring the formation of clot by altering the course of the blood-current.

Many plans have been tried to produce clot in thoracic and abdominal aneurysms by surgical means, but most have proved immediately dangerous to life.

MacEwen's Method is not a dangerous one, and has been followed by some success. Long fine steel needles are passed into the sac until the point comes in contact with the posterior wall, which it scratches. The needles are so fine that bleeding does not follow their withdrawal. The rough surface produced by scratching the wall is supposed to favour the formation of laminated clot.

Aneurysms by Anastomosis—Cirsoid Aneurysms.—These are congenital conditions in which an arterial trunk breaks up into a plexus of thin-walled vessels. They occur on the temporal artery, on the occipital artery, and occasionally in the limbs. They are diffuse pulsating swellings, composed of a number of arteries. The treatment is removal by excision, the vessels being divided between clamp forceps around the margin, and afterwards tied.

Nævi.

Venous Nævi occur partly in the skin, partly in the subcutaneous tissue, also on the tongue and cheek, and occasionally in muscle or periosteum. They are composed of dilated anastomosing veins separated by some fat lobules. The colour is blue, the tumour is reduced by pressure, and distends again without pulsation.

Capillary Nævi occur on the skin, being either circumscribed, or diffused as 'port-wine stains.' The red colour disappears on pressure. A nævus may be partly capillary, partly venous.

Small circumscribed nævi can be excised, or, if very small, destroyed by the actual cautery point. Diffuse nævoid conditions about the face and lips may be treated by electrolysis. A large-celled battery is connected with three needles attached to the anode, and two to the cathode; these are plunged into the swelling, and the current turned on just sufficiently to cause bubbles at the cathode. After a few minutes, dark blood-clot is seen forming around the anodes. This must not be continued long enough to cause an eschar. The anodes being fixed in the blood-clot whilst the cathodes remain smooth, the current must be reversed in order to withdraw the anodes without causing hæmorrhage. The part can then be covered by wool and collodion. Several sittings are generally necessary. After each, some inflammation ensues which obliterates vessels. So long as only a little is done each time, cure will follow without scarring.

Surgery of Veins.

Wound of Large Veins.—If at the moment that a large vein is punctured a deep inspiration be taken, air may be sucked in and churned up into a froth in the right heart. The result is a failure of the circulation through the lung to the left heart, and sudden death from cessation of the blood-supply to the heart wall and to the medulla. The entrance of air into a jugular vein may be the cause of sudden death in cut-throat. There is not now the danger of air entering during operations as there was before anæsthesia was introduced, for under a general anæsthetic the veins are kept full, and no sudden gasp is taken. Yet large veins should always be ligatured or clamped before being cut.

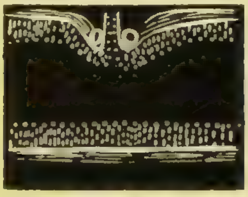


FIG. 34.—LATERAL LIGATURE, CLOSING PUNCTURE IN VEIN.

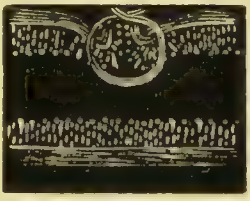


FIG. 35.—SUTURE OF WOUND IN VEIN.

The Wound of a Superficial Vein.—This may be accidental or suicidal, or it may arise from the bursting of a varicose vein. If the part be a dependent one, fatal hæmorrhage may follow. On the other hand, by raising the part and applying pressure, the bleeding is easily controlled.

When a superficial vein is wounded, upon which pressure cannot be made, *e.g.*, a vein of the scrotum, the bleeding-point is transfixed either by a harelip pin or by a suture.

If a large vein be wounded, a lateral ligature may be applied by pinching up the puncture in the wall (Fig. 34), or by uniting it by a fine suture (Fig. 35).

Excision of Varicose Veins.—Varicosity is essentially due to congenital weakness of the wall, which causes it to yield even to the ordinary venous blood-pressure, but more especially if any cause of venous obstruction be super-added.

A mass of anastomosing veins in the subcutaneous tissues forms a venous nævus. In the scrotum the dilated veins of the pampiniform plexus constitute varicocele. The internal and external saphena veins, when distended and tortuous, are the typical varicose veins. The dilatation of the inferior hæmorrhoidal ring of veins is the condition known as piles or hæmorrhoids.

The varicose veins undergo thrombosis, and the thrombus causes inflammation and thickening of the vein wall, but the thrombosis very rarely obliterates, and so cures the varicosity. Hence, if the dilatation cannot be controlled by gentle pressure, the dilated veins must be excised.

Venesection.—Superficial veins are incised for the removal of blood and for the injections of fluid. The superficial veins at the bend of the elbow are generally chosen, but the external jugular in the neck, or the dorsal vein on the foot, are in exceptional cases the site of the operation.

Venesection is now limited to cases of acute pneumonia, of apoplexy, and of heart disease causing over-distension of the right auricle, the blood then being taken from the right external jugular. There is no objection to the operation, but opinions differ as to its utility. The patient is seated, the arm hangs down, a bandage is applied as shown in the drawing (Fig. 36), tightened, so as to obstruct the veins, and fixed by a single bow. The surgeon grasps the upper part of the forearm with his left hand, the thumb being placed upon the distended vein just below the point for the incision. This should be made by preference at the place where the vein is separated from the artery by the bicipital fascia. A puncture is made with a lancet, which then cuts itself out, so making a $\frac{1}{4}$ inch opening into the vein. A scalpel does just as well as a lancet. The line of the incision is in the axis of the limb, and is therefore oblique to the course of the vein. On turning the arm inwards and relaxing the thumb, blood flows into a bowl. Ten ounces may be removed, or the flow may be allowed to continue until the patient, whilst sitting up, shows the first sign of faintness, either by losing colour or by complaining of giddiness or nausea. The puncture is thereupon covered by the thumb, a pad of gauze is slipped under it, the single bow of the bandage is drawn on, and then the bandage taken round, as shown in the diagrams (Figs. 37 and 38), and tied, so that the arm can be flexed to a right angle without disturbing the pressure on the pad. The arm is kept in a sling for a day or two until the puncture has healed. A good flow of blood is obtained by compressing the veins, but not the artery, and by making a sufficient incision. It may be improved by a conscious patient repeatedly grasping and relaxing his hold of a stick, or the forearm may be firmly stroked and squeezed upwards from the wrist.

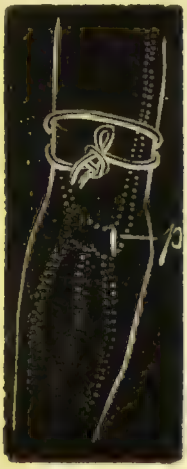


Fig. 36.—Venesection Bandage controlling Circulation.

p, Site of puncture.

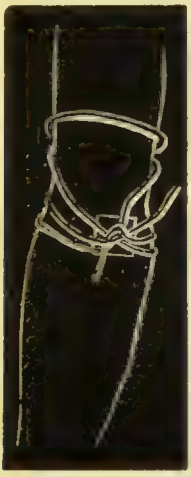


Fig. 37.—Venesection Bandage, Front View.

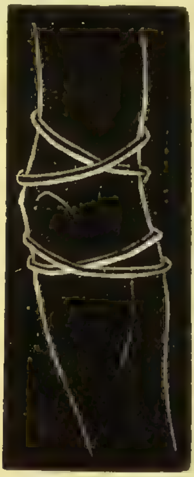


Fig. 38.—Venesection Bandage, Back View.

Venous Injections.—The vein is compressed as in venesection. A hypodermic syringe is employed of a size corresponding to the dose of the fluid. The syringe must be rendered aseptic by repeated washing with 5 per cent. carbolic acid, which is completely removed by a final washing with absolute alcohol. Some syringes can also be sterilized by boiling in soda solution. The distended vein is punctured by a sharp needle, and the needle pushed upwards within the vein. Then by moving the point it can be seen that the needle is free in the lumen. The compression on the vein is relaxed, the fluid injected, and the puncture covered by collodion after the needle is withdrawn. No pain is caused when a soluble salt of mercury is so injected. If the needle is not in the vein, its point will not move freely, and pain will be caused by the injection even of a drop into the tissues outside the vein.

Infusion into Veins.—Fluid is best infused into a vein in front of the elbow through a glass funnel, united by 4 feet of rubber tubing to a glass cannula which ends in a nozzle. There is a neck at the base of the nozzle, and its orifice is oblique. A gum-elastic catheter, attached to a ball syringe by a short piece of rubber tube, will serve on an emergency.

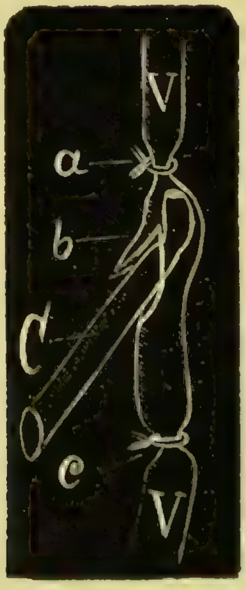


FIG. 39.—CANNULA INSERTED INTO VEIN.

V, Vein; C, cannula; *a*, proximal temporary ligature; *b*, incision into vein into which cannula is tied; *c*, distal ligature.

The vein is exposed by an incision about 1½ inches in length; the distal end of the vein is tied (Fig. 39), the proximal end being compressed either by the hand or by forceps, or by passing a ligature and fixing it with a single bow. The wall of the vein is raised by fine forceps, and an oblique cut made into it by scissors. The flap so cut is held by the forceps, whilst the cannula is slipped in and fixed by a ligature, which includes the vein and cannula at its neck, but before doing so the whole apparatus must be full of water, all air having been driven out. Salt solution is used, made by adding 75 grammes to the litre, *i.e.*, 72 grains, or a full teaspoonful, to a pint of water. The fluid must be at blood-heat, and the injection is continued until the pulse improves; 2 or more, up to 5 or 6 pints as the extreme limit, are injected. The fluid is allowed to flow slowly by raising the funnel as high as 3 feet from the level of the arm. If a syringe is employed, force just sufficient to cause a flow is applied. The proximal end of the vein is next tied, and then the piece of the vein between the two ligatures, including the hole for the insertion of the cannula, is cut out. The skin wound is finally sutured.

CHAPTER VI.

SURGERY OF LYMPHATICS AND LYMPHATIC GLANDS.

Acute Lymphangitis.

ACUTE septic inflammation may be confined to the lymphatic channels, or be diffused.

The lymphatic trunks become tender and thickened, appearing as red streaks, and feeling like cords. The vessel may remain patent, or a thrombus forms, and the thrombus breaks down into an abscess. The lymphatic glands receiving the inflamed lymphatics remain simply tender, or enlarge and suppurate.

If diffused, the inflammation causes a brawny œdema, and the inflammatory exudation breaks down into pus, forming discrete abscesses or widespread cellulitis.

The treatment consists in destroying all septic matter at the site of inoculation, applying hot fomentations and extract of belladonna, and watching for signs of suppuration. Tense painful swellings should be explored by puncture, so as to save extensive suppuration.

Subacute and Chronic Lymphangitis.

Subacute and chronic lymphangitis follow an acute affection, or from a milder action of the same causes. In the tropics parasites—*e.g.*, *Filaria sanguinis hominis*—originate it. In some cases, however, neither of these causes has been at work. The result of chronic lymphangitis is the obliteration of some lymphatics and the dilatation of others, hence œdema, lymph vesicles, which burst and produce fistulæ, together with great increase of the connective tissue of the skin and subcutaneous tissue, called **Elephantiasis**.

Subacute and chronic lymphangitis is treated by hot fomentations and belladonna, and by elevation of the limb. Moreover, the soaking of the part in hot water, and repeated stroking towards the trunk, favour the return of lymph and the opening of anastomotic channels. Careful bandaging of the extremity upwards towards the trunk by elastic bandage is also of service. If taken early, anastomotic channels will develop. If not, although the œdema may have become much less under elevation, massage, and bandaging, as soon as the limb hangs down again, the œdema recurs. The only treatment of elephantiasis when established is removal. This is carried out on the scrotum or vulva. It is a more difficult question when a limb is involved, and a decision as to amputation must be settled according to the wishes of the patient. Ligature of the main artery is of no permanent service.

Chyle, Encysted or Free in a Cavity.

An obstruction in the course of the thoracic duct or its tributaries leads to the collection of chyle either as free fluid in the pleura, peritoneum, or tunica vaginalis, or it may collect in a cyst of the mesentery, or appear mixed with the urine. The cause is unknown as far as regards this country; abroad the condition may be of a parasitic origin, due to *Filaria Bilharzia.* Chyle is recognised by its pinkish-white colour, containing fat globules and white corpuscles, and by clotting on standing after it has been drawn off. If after tapping the cyst or cavity fill again, it must be incised, washed out and drained, or the cyst wall may be excised. The prognosis will depend upon the amount of anastomosis. Chyle may continue to escape, and so gradually exhaust the patient, or the flow stop and the patient recover.

Acute Inflammation of Lymphatic Glands—Acute Lymphadenitis.

Except in plague, acute inflammation of a lymphatic gland is of local origin. The glands become much enlarged, painful, and the skin and superficial structures are also inflamed. Rest, the application of belladonna, and hot fomentation relieve the pain.

Suppuration.—If the swollen glands begin to soften, and the overlying skin to pit, pus is forming in the centre of the gland. The gland should be incised at once, its interior scraped out, and treated with a strong antiseptic. The surgeon ought not to wait until there is fluctuation, for then a large abscess will have formed by fusion, and a more tedious recovery and greater scarring will ensue.

The most dangerous type of septic infection causes rapid swelling of the glands, with acute œdema of the surrounding tissues. The immediate and thorough treatment of the site of inoculation, the excision of the glands, and the filling of the remaining wound with gauze, are the surgical means likely to save life, and this may be combined with the administration of antistreptococcic serum.

Chronic Inflammation of Lymphatic Glands—Chronic Lymphadenitis.

The main structure of the lymphatic gland is at first retained, there is greater vascularity, and an increased number of lymphocytes as the result of proliferation. Later on three changes occur: the increase of fibrous tissue, caseation going on to suppuration or calcification, and continued increase of the gland elements to form a tumour—lymphadenoma.

The two known general causes are tubercle and syphilis, besides which there are a great variety of local ones. Syphilitic glands disappear under the influence of mercury and iodide of potassium administered internally, and also applied locally.

Tubercular glands may subside under general treatment, such as cod-liver oil, iron, and country or sea air, aided by the application of mercurial or iodine ointments. When caseation commences, the glands begin to soften, and this is a signal for their removal, whilst they will still shell out from adjacent structures and before infection by septic organisms. When inflammation has extended outside the gland to neighbouring tissues, one of two courses may be adopted. If limited and free from important structures, the whole mass is excised from the healthy tissues; the wound should heal at once, and the scar become less and less perceptible. This plan should not, however, be adopted when the disease is extensive if large veins or arteries are involved, if the patient is a weakly child or anæmic girl, for then complete excision is too dangerous, considering that the disease is not directly a fatal one. In such cases the glands are incised, and scraped out, so that most of the tubercular disease is removed, whilst the inflammatory capsule, which is only partly affected, is left. The wound can then be filled with gauze. Healing will be longer, and the scar more marked and perhaps permanent.

Tumours of Lymphatic Glands—Lymphadenoma—Lymphosarcoma.

Owing to some local source of irritation, one or more glands continue to enlarge without tending to suppuration or caseation. The only microscopical change is an increase of fibrous tissue, which varies much in different cases. The glands yield an elastic or doughy sensation, but do not at first involve the tissues around. Whilst originating locally, there is a tendency, showing itself sometimes early, sometimes very late, for lymphadenoma to become malignant, **Lymphosarcoma.** Lymphadenoma is treated by arsenic in increasing doses, which may be supplemented by iodide of potassium, both internally and locally by inunction. If this treatment does not succeed, the tumour should be excised. Many of the gland masses shell out easily, and if only partial removal can be done, yet the medicinal treatment may afterwards be more successful. When it is borne well, arsenic may be injected into the tumour (*e.g.*, liq. arsenicalis ♏x.).

Malignant Disease of the Lymphatic Glands—Sarcoma and Carcinoma.

The more favourable kinds of sarcoma and carcinoma do not infect lymphatics. Instances of this in the case of sarcoma are fibro-sarcoma and giant-celled sarcoma of bone ; in the case of carcinoma, rodent ulcers of the skin ; in epithelioma of the lip or of the scrotum the infection of the glands is very slow. Rapidly growing sarcomas, *e.g.*, periosteal sarcoma, sarcoma of the breast or of the testicle, cause early infection of the lymphatic glands, so do also all kinds of glandular carcinoma. Unfortunately, in such cases extension goes on through the glands to the viscera. The principle governing the removal of all cases of cancer, except the mild types noted above, consists in not only removing the whole apparent disease by cutting through the healthy tissue, but in studying the course of the lymphatics to the neighbouring glands. The lymphatics and glands are then removed with the fascia enclosing them, for the microscope reveals infiltration of glands which cannot be detected otherwise. This extension of the operation for malignant disease is now possible owing to the better healing of wounds, and even if not ultimately successful, yet recurrence is staved off for a much longer period.

CHAPTER VII.

SURGERY OF NERVES.

Union of Divided Nerves.

Primary Suture.—Any large nerve which is divided in a wound must have its ends carefully adjusted and sutured. One suture is passed through the whole thickness of each end, and then a more superficial suture is inserted on either side (Fig. 40). The most important place for this union is in the case of a cut wrist. When the union is successful, sensation returns at once to a large extent, and movement is restored after the healing of the wound.

Secondary Union. — When the cut ends of a nerve are not approximated, or become separated again by suppuration, the proximal end forms a bulbous enlargement consisting of connective tissue, amongst which are coiled axis-cylinder fibres, which have in vain attempted to grow downwards. The distal end is much shrunken, owing to partial degeneration. Nevertheless, there are always some nerve fibres to be found in it, whether due to persistence or to regeneration is uncertain. The signs of an ununited nerve are the loss of function in the part supplied, the loss of sensation and of motion, the wasting of muscles; the skin loses its papillæ, becomes smooth and glossy, of a dusky red colour, cold, and liable to chronic ulceration, which shows no sign of healing, but goes on to necrosis of bone. Although

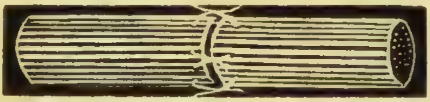


FIG. 40.—SUTURE OF NERVE.

complete recovery is to be looked for only in recent cases, yet after so long a period as one to two years considerable improvement takes place if the ends can be brought together. The ends of the nerve have first of all to be dissected out from the scar-tissue which surrounds them, and the course of the nerve must be followed upwards and downwards until both ends are free. The proximal end may be stretched a little, and tension is relaxed by bending the limb. If, however, the proximal end does not reach the distal, it can be split (Fig. 41) and a portion turned down, or a nerve trunk or portion of the spinal cord from an animal can be grafted in (Fig. 42). If success attends the union, there is some early recovery of sensation, and later of movement, the extent depending upon the time which separated the injury from the operation.

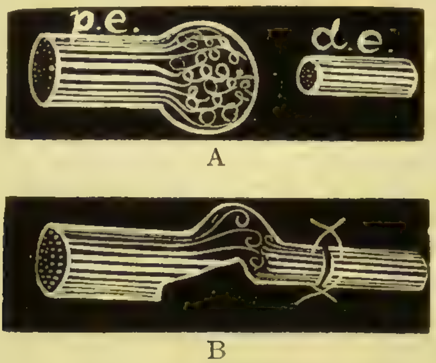


FIG. 41.—SPLICING OF NERVE.
A, *p e*, Proximal end, bulbous; *d e*, distal end, atrophied.
B, Splice turned down and fixed by suture.

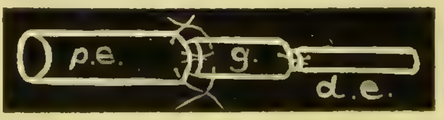


FIG. 42.—NERVE-GRAFTING.
p e, Proximal end; *g*, graft; *d e*, distal end.

Dislocation of a Nerve.

The ulnar nerve, in particular, as it passes behind the condyle of the humerus, is liable to dislocation. Replacement is made by thumb-pressure. When the accident recurs from slight causes, it becomes necessary to fix the nerve in position by fine sutures.

Adhesions and Scar Tissue compressing a Nerve.

A nerve may be included in the callus of a fracture, or in the scar tissue which follows an injury. In consequence there is local pain, with partial paralysis. The nerve is cut down upon, and freed by dissection from the scar tissue.

Nerve-Stretching.

This is employed for the relief of neuralgia, but is only of permanent service when it is the means of freeing the nerve from adhesions. The nerve is exposed, and a hook or the finger passed beneath it. The stretching is done by a steadily-applied force free from jerks, the force being regulated by the size of the nerve, and continuing until the nerve lies slack in the wound. The consequent anæsthesia soon disappears.

Neurotomy.

The simple division of a nerve is generally useless. It would be usually required for the relief of neuralgia affecting one of the branches of the fifth nerve which are not under tension, and as the cut ends would not separate, they would quickly unite again and the neuralgia return. The nerves of the limbs are under tension, and the cut ends widely separate when accidentally divided, but neurotomy on them for neuralgia or spasm is very rarely required.

Neurectomy.

A piece of at least 1 to 2 inches may be cut out of a sensory nerve for the relief of neuralgia, but it can only be of service where the neuralgia arises in the distal portion of the nerve, and fails when the pain originates above the point of section.

Avulsion of a Nerve.

A nerve is seized, drawn up by a hook, then grasped by clamp forceps, and wound up by twisting the forceps until its branches or its roots, as the case may be, are drawn out. The peripheral ends of the fifth nerve may be avulsed for neuralgia, the ends of the facial for spasm or tic douloureux, and the proximal end of the spinal accessory has been drawn out for spasmodic wry-neck.

Excision of a Nerve Ganglion.

The ganglia on the fifth nerve, especially the Gasserian ganglion, may be excised in order to abolish trigeminal neuralgia. Posterior root spinal ganglia may be similarly treated.

Tumours of Nerves.

The benign tumours are soft fibromata. The tumour is in the course of a nerve trunk, causes neuralgic pains, and muscular paresis or wasting of the skin, corresponding to the distribution of the nerve. The tumour is fixed in the long axis of the nerve, but has some mobility in the transverse direction. The tumour grows from the connective tissue covering the nerve, and nerve fibres are spread out over the tumour. The capsule must be divided in the long axis of the nerve, the nerve fibres pushed aside, and the tumour shelled out.

Multiple fibromata or fibroneuromata form on the nerve ends in the skin, or on the course of a nerve or its roots. Those which cause much pain may be excised.

The malignant tumours are sarcomata, infiltrating the whole substance of the nerve, and very quickly spreading to the surrounding tissues. Excision of the affected portion of the nerve is required, followed by grafting. If this is not done early, or recurrence ensues, amputation becomes necessary.

CHAPTER VIII.

SURGERY OF MUCOUS CAVITIES AND TUBES.

All mucous tubes and cavities have two coats in common—a mucous and a muscular coat. They differ in that there may be a serous coat outside or not. The interior of these tubes and cavities is essentially septic, and cannot by any means be rendered aseptic or maintained so after the operation.

Mucous membrane unites to mucous membrane or to skin at the cut edges and on the deep aspects, not by the free surfaces. Any protrusion of mucous membrane between the muscular coats prevents union. The other two coats, muscle and serous membrane, unite well, both by surface as well as by the cut edge.

For union, therefore, any method of suturing must ensure an air-tight and water-tight closure, and allow no mucous membrane to get between the muscle coat. This can be done by two rows of sutures; the inner one, passing through all the coats, unites them firmly with the mucous membrane turned in, the outer superficial row through serous (when present) and the outer part of the muscle coat, which when tightened buries in the deeper suture. There can then be no leaking along a stitch puncture from the mucous membrane outwards. If for lack of time only one row is employed, then the latter, and not the former suture, is required. The stitches should be a little deeper, closer, and drawn tighter, but none must perforate to the mucous membrane, or the septic contents will escape along the stitch.

Ordinary sewing needles, straight or curved, are threaded with the finest strong silk, and used as a simple continuous suture.

Union of a Linear Wound (Figs. 43, 44).

The edges being pinched up so as to prevent contamination for the time with the septic contents, are wiped with a sponge dipped in 5 per cent. carbolic acid or 1 in 1,000 sublimate. All large bleeding-points are ligatured, but the smaller ones stop when the wound is drawn together. Beginning at one end, the first stitch is inserted through enough serous (if present) and muscular coat to hold firm, but through as little as possible of the mucous membrane. The first stitch is knotted and the free end cut short; then the continuous suture is taken to the other end, drawn up sufficiently tight, and fixed by a slip-knot.

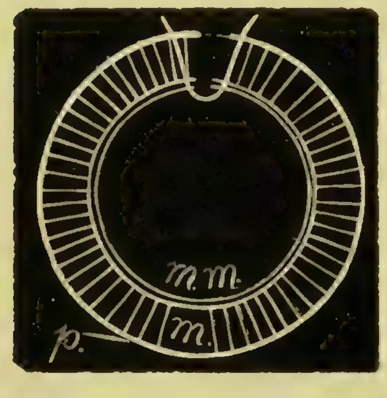


FIG. 43.—SUTURE OF LINEAR WOUND OF MUCOUS TUBE.

Suture passes through all three coats. *p*, Peritoneum; *m*, muscle; *m m*, mucous membrane.

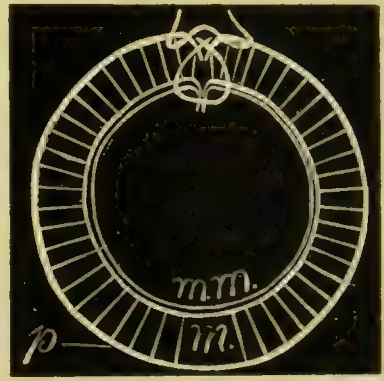


FIG. 44.—SUPERFICIAL SERO-MUSCULAR SUTURE.

The suture is passed through the peritoneum and part of the muscular coat, so that, when tied, the first suture through all the coats is buried.

The outer suture is carried through serous and the superficial portion of the muscle coat by holding the needle parallel to the line of suture, passing it in and bringing it out again some 2 to 3 millimetres off. The first stitch is knotted, and the free end cut short, then the needle is passed from side to side over the first suture, so that when the second is drawn tight the first suture is buried by the bringing together of the outer coat over it. The outer or sero-muscular suture must begin and terminate well beyond the ends of the wound to be closed.

The Circular Suture for uniting Mucous Tubes End to End.

The openings into two tubes or cavities can be closely united so that they become continuous. Should one opening be at first larger than the other, the larger one is reduced as much as necessary by a linear suture.

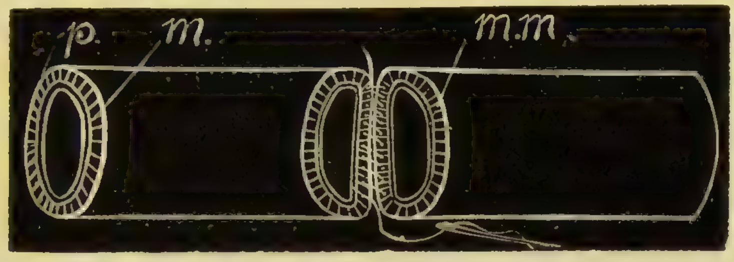


FIG. 45.—END-TO-END UNION OF MUCOUS TUBES BY CONTINUOUS SUTURE. Posterior sero-muscular suture inserted. *p*, Peritoneum; *m*, muscle; *m m*, mucous membrane.

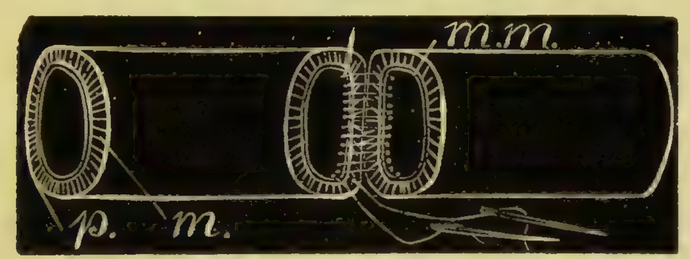


FIG. 46.—END-TO-END UNION OF MUCOUS TUBES. Posterior Suture through all Coats, *p*, Peritoneum; *m*, muscle; *m m*, mucous membrane.

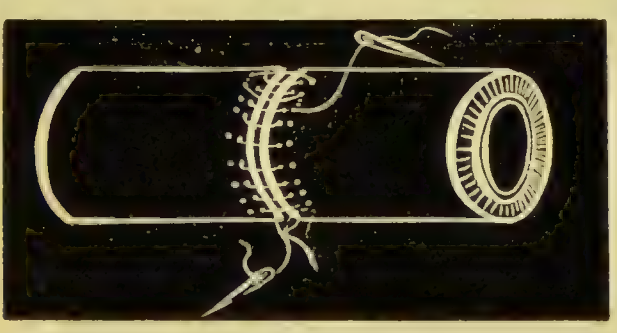


FIG. 47.—END-TO-END UNION OF MUCOUS TUBES. Anterior Suture through all Coats completed. Anterior sero-muscular suture partly passed (compare Fig. 44). Dots indicate where the remainder will pass.

The two continuous rows of sutures are applied as for a linear wound, but they now travel round in a circle to the starting-point (Figs. 45, 46, 47), and there the threaded end of each is finally tied to the free end of its first knot. The inner one includes all three coats—the outer, the serous (if

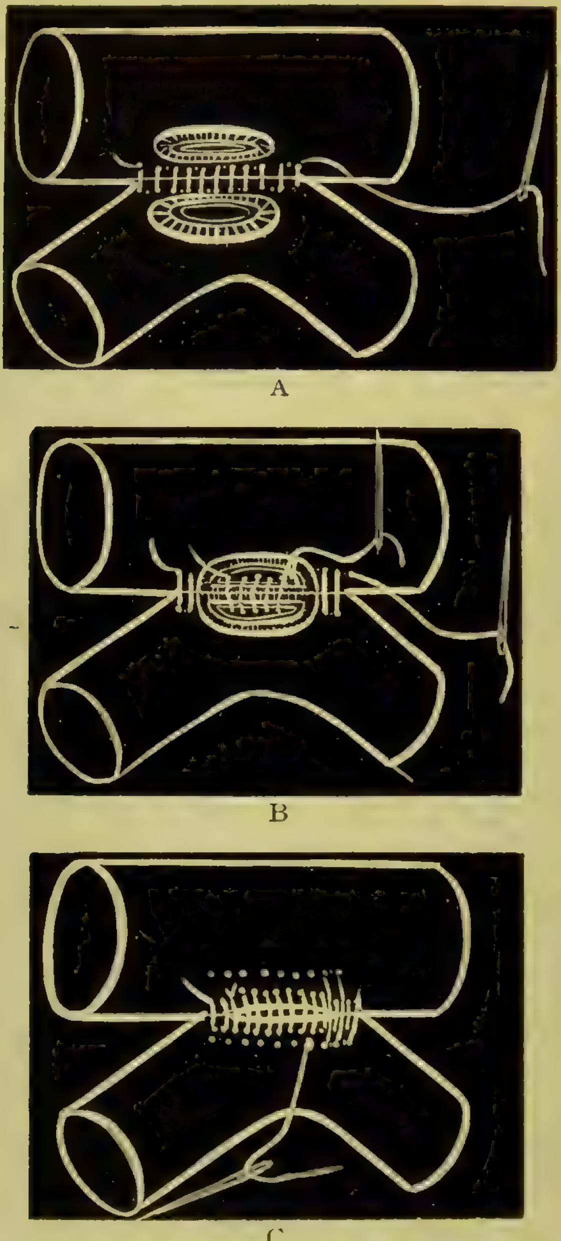


Fig. 48.—Anastomosis of Mucous Tubes by Continuous Suture.

A, Posterior sero-muscular suture: dots indicate the points of insertion of the following suture; B, posterior suture through all coats; C, anterior suture through all coats completed: anterior sero-muscular suture partly passed: dots indicate the points for insertion of the rest. (Compare Figs. 43 to 47.)

present), and superficial portion of the muscular coat—and buries in the inner one.

But when it is difficult to get round the posterior half of the circle with the outer suture, it is inserted first of all. The posterior half of the outer suture is inserted at 2 or 3 millimetres from the edge, the free end of the first knot being left long, and the threaded end held by clamp forceps, whilst the inner suture is inserted all round through all the coats, drawn tight, and knotted to its free end. Finally, the outer sero-muscular suture is completed round the anterior half of the circle and knotted to its free end. Special means have to be employed for preventing the contents from soiling the wound, the edges of which should be wiped before uniting them. The sero-muscular suture is the more important, and may be used alone if time presses. It is then best to cut the mucous membrane well back to avoid protrusion between the muscular layers.

Anastomosis between Two Mucous Tubes (Fig. 48 A, B, C).

The circular suture is used for forming an anastomosis, *e.g.*, between the stomach and duodenum, or between the small and large intestines. The outer suture is sero-muscular; the inner passes through all the coats, taking up as little mucous membrane as possible. The two tubes having been brought together, and the position of an opening 2 to 3 cm. in length selected, the posterior half of the outer suture is inserted about 2 to 3 millimetres behind the line of the incision; then the two incisions are made, the inner suture carried completely round and tightened; finally the anterior half of the outer suture is finished.

Maunsell's Method of suturing by making an Intussusception (Figs. 49, 50).

A suture is inserted at the mesentery border through all three coats, and another at the opposite border, so as to fix the two tubes. The ends of the sutures are left long, so that they can be drawn through a linear longitudinal incision made in the distal tube opposite the mesentery, a little way below the line of union. This is easily done by transfixing a transverse fold. Through the linear incision the free ends of the sutures are drawn, and by this means, aided by pressure upon the proximal tube, an intussusception is produced through the linear incision. The ends so protruded are united all round by interrupted sutures passed through all the coats (Fig. 50). The sutures are cut short, the intussusception withdrawn, and the linear wound closed as in Figs. 43, 44. This plan is particularly adapted for the removal of a gangrenous intussusception.

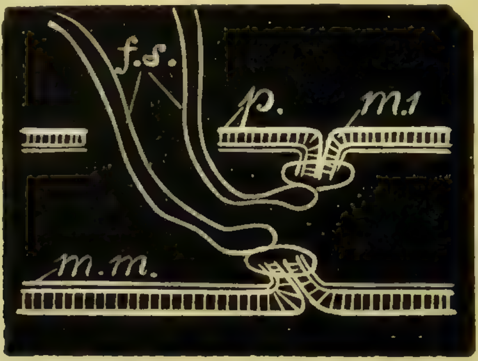


FIG. 49.—MAUNSELL'S SUTURE: FIRST STAGE.

p, Peritoneum; *m*, muscle; *m m*, mucous membrane; *f s*, fixation sutures, which being drawn on produce an intussusception, and bring it out through the linear wound.

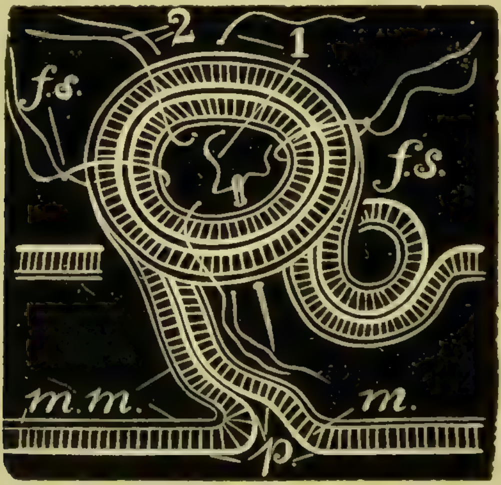


FIG. 50.—MAUNSELL'S SUTURE: SECOND STAGE.

p, Peritoneum; *m*, muscle; *m m*, mucous membrane; *f s*, *f s*, fixation suture: 1, suture partly passed; 2, suture divided ready for knotting.

In whatever way the suture be used, the contents of the bowel must be kept back. The finger and thumb of each of the assistant's hands may do this, but it is best to clamp the bowel in some way. A drainage-tube is passed through a hole in the mesentery, tightened by one loop and fixed by clamp forceps. Or a safety-pin is inserted, so as to include the intestine and a piece of sponge; on closing the pin, the sponge presses upon and occludes the lumen of the intestine. Special intestinal clamps are made which close the lumen without injuring the gut.

The suture remains the fundamental method, for it is simpler, needs no special apparatus, and therefore possesses greater adaptability to the particular difficulties of the individual case, yet there can be no doubt that special appliances have successfully enlarged very much the field of intestinal surgery. They have rendered the operations easier and quicker in the hands of many surgeons.

The objection to their general use lies, firstly, in the apparatus required; secondly, in the lack of adjustment for special cases; and thirdly, in introducing a fresh series of complications by the presence of a foreign body.

Murphy's Button.

This is an ingenious apparatus consisting of two parts, each with a flange and a tube. The male tube fits into the female, so that the two layers of intestine are held between the flanges until union round the edge takes place, whilst the part pinched sloughs.

Round the edge of each of the two cavities to be united a continuous circular suture is run through all the coats, so that when the two ends of the suture are drawn up the cavity is brought together like the mouth of a bag. The flange is inserted into the hole, whilst the tube projects, and then the bag-suture is tightened up round the projecting tube. This is done on both sides, and the male is pushed firmly into the female portion of the button. There may be some saving of time in the use of this button, especially in the union of the gall-bladder to the duodenum, which, by suture only, is difficult and tedious. The objections are the necessity of having several sizes of an expensive apparatus, the difficulty of getting the bag-suture tightened up round the neck of the tube, the disagreeable fact that sometimes the two halves cannot be pushed home from something having got in the way, and then the whole button has to be cut out and the operation recommenced. After the operation the button has remained in the body, and has originated a fatal perforation, or a special operation has been required for its removal. The position of the button is shown by the X-rays.

Decalcified Bone Bobbins.

These simple objects are used as adjuncts to the sutures already described, because it has been found easier to tighten up the continuous sutures over them. Robson's bobbins are in size and shape like a cotton bobbin, except that the bore is larger; Allingham's are shaped like a dice-box. An inch of large rubber-tubing will do, or a tube may be cut out from any handy object like a potato or turnip. No objection can be raised to such aids, but it is the suture which is the essential part of the process.

After the principal part of the operation has been concluded, supplementary sero-muscular or Lembert's interrupted sutures may be put in wherever there is a need.

CHAPTER IX.

SURGERY OF THE SKIN.

Boil.

A LOCAL acute septic inflammation produces a small slough, ulcerating through the skin at a single point and causing much pain from tension.

The pain is relieved by early puncture after freezing or after dropping pure carbolic acid on the apex, or it may be done under nitrous-oxide gas. Hot fomentations are then applied. Ill health, especially from work in confined rooms, causes young men to be attacked by successive crops at the level of the collar, or in the gluteal region. Change of air and tonics are then necessary.

Carbuncle.

A more extensive inflammation causing a large slough and opening upon the skin by more than one point forms a carbuncle. Carbuncle is practically limited to the dorsal region, extending from the nape of the neck to the sacrum, and occurs especially in middle-aged patients who are exhausted from want or over-work, and it also complicates diabetes and chronic alcoholism. Signs of fever are present, with great pain, and generally some glycosuria. It is necessary to distinguish temporary glycosuria from the occurrence of carbuncle as a complication of diabetes.

A patient suffering from carbuncle should be at once anæsthetized, an incision made, and the tough slough cut or scraped away without entering upon the healthy tissues around. The surface left is dusted with iodoform, and dry dressings or fomentations are applied to relieve inflammation.

Thus treated, a carbuncle may be nearly healed after ten days, whereas if the sloughs are left to separate of themselves a month or more would be taken up, and meanwhile the patient become greatly exhausted.

Ulcers.

Tubercular and syphilitic ulcers are the most common. Tubercular ulcers may be scraped, and a strong antiseptic applied, or they are excised and skin-grafted. Syphilitic ulcers may be complicated by phagedena, which is stopped by painting with pure carbolic acid. When they do not heal under medical treatment, the surgical measures used for tubercular ulcers become necessary.

Tumours of the Skin.

A Papilloma or Wart consists of an overgrowth of the epidermis and papillæ of the dermis with a small artery running up the centre, and is produced by irritation. A wart is cut off and the base cauterized. (See External Piles, Gonorrhœal and Scrotal Warts.)

Sebaceous Cyst.—A sebaceous cyst is due to the obstruction of the duct by a plug of inspissated sebum, behind which the secretion collects and distends the alveoli into a unilocular cyst, surrounded by a white friable wall of connective tissue. The contents consist of a cheesy or curdy mass, having a peculiar odour given off by fatty acids. At the most prominent point is a black spot marking the obstructed duct. Immediately around this the cyst wall is closely adherent to the skin, but the rest is easily separated from the connective tissue. A sebaceous cyst is to be distinguished from the dermoid cysts, which are lined by true skin, and are not obstruction cysts. The so-called sebaceous cysts of the scalp are dermoid. A sebaceous cyst may suppurate, or its wall become calcified. If the wall ruptures, the interior becomes everted; from it grows a horn, and in process of time an epithelioma will develop.

A sebaceous cyst is transfixed, the cyst wall seized and dragged out. It is not dissected out, owing to the close adherence to the skin at the most prominent part. A small one is punctured, and into the interior is inserted a crystal of nitrate of silver. The next day the cyst wall can be drawn out through the puncture. When inflammation and suppuration have taken place, the cyst wall becomes adherent, and then must be removed by scraping.

Nævi, see p. 76.

Molluscum Contagiosum.—This is a small tumour about the size of a pea, having an umbilicated depression in the centre. It consists of a mass of epithelial cells, and is due probably to a parasite, setting up proliferation in the deepest layers of the epidermis. It is found on the face, eyelids, and hands of children, and is thus transmitted to the face of nurse-girls, and to the breasts of mothers. The tumour may suppurate. It is excised.

Lipoma.—A fatty tumour grows from the deeper layers of the dermis and spreads into the subcutaneous tissue. The skin over the surface is puckered owing to the attachment of the tumour, which is lobulated, and so easily movable on the deep structures that the tumour slips away when the finger is pressed upon the margin. The tumour in course of time becomes pendulous, and the skin ulcerates over the surface. They are most commonly seen on the back from the nape of the neck to the buttocks, but are also met with in the skin of other parts. Those in children and young adults have originated in nævi. Fatty tumours growing from the subcutaneous connective tissue are diffuse lipomata (see p. 111).

A lipoma of the skin is included in an oval incision, and easily shells out, being comparatively non-vascular.

Fibrous Tumours.—Fibromas of the skin are commonly composed of soft, tough fibrous tissue, mixed with some fat. They are generally multiple, and tend to become pendulous, when they are known as molluscum fibrosum. Any which cause trouble are removed.

A densely fibrous tumour less often grows singly, and ultimately the skin ulcerates over it. It is encapsuled and easily excised.

A diffuse fibrous thickening of the skin is known as diffuse fibrosis, or diffuse fibroma, or by the term pachydermatocele. The mass hangs in folds of tough, soft tissue, interspersed with masses of denser structure. Removal is always advisable whenever it is practicable.

Malignant Tumours of the Skin.—Malignant tumours of the skin quickly form ulcers with indurated edges and bases.

Rodent Ulcer is the name given to a slow growing type of carcinoma, which lasts for years, and does not infect lymphatic glands. They grow generally from sebaceous glands, less often from the Malpighian layer, the sweat glands, or the hair follicles. They are most commonly seen on the face below the inner canthus, but are occasionally met with on other parts.

They are especially favourable for excision.

Epithelioma or Squamous-celled Carcinoma.—When epithelioma arises in the skin it is often secondary to a chronic eczema, ulcer, or fistula. It is distinguished from a rodent ulcer by a more rapid growth, and by infecting the corresponding lymphatic glands. It shows numerous nest-cells, whilst only a few are exceptionally met with in rodent ulcer.

In excising an epithelioma, it is not only necessary to excise the ulcer freely, but also the infected lymphatic glands, and the lymphatics connecting them with the ulcer.

Glandular Carcinomas and Sarcomas of the skin are usually secondary and multiple, and therefore not amenable to surgical treatment. Any rapidly-growing single tumour, a gumma being excluded, must be at once explored, and if possible excised.

Scars.

Scars are prevented by exactly uniting a wound with antiseptic care, so that healing takes place by first intention. The incision is made whenever possible in the line of a natural fold, and after a year or two the scar is scarcely seen.

A scar is softened and rendered supple by massage and by the application of belladonna. Eczema and inflammation are prevented by frequent washing and protection, and are relieved by hot fomentations and antiseptic ointments.

If the scar is depressed, a tenotome may be passed beneath it, so as to divide its deep connections.

If the scar is painful, the offending nerve-twig may be cut down upon, and as much as possible of it torn out.

Irregular puckered scars are excised, so that, after healing by first intention, they may be replaced by linear scars.

Keloid, *i.e.*, a local slow-growing form of sarcoma, also epitheliomas, arise in a scar owing to irritation; the scar may be infected by the recurrence of a deep-seated cancer. In such cases excision is required whenever practicable.

Restoration of Skin—Skin-Grafting.

Whenever much skin has been removed, the wound is covered in by one of three methods:

1. **Undermining the Neighbouring Skin.**—When the neighbouring skin is only loosely attached, and there are no important veins or lymphatics likely to be injured, the skin is raised by blunt instruments or the fingers. A surprising amount of extensibility is gained when the skin is thus separated from the subjacent tissue. The wound must not be tightly bandaged, so that there may be a sufficient anastomotic circulation.

2. **Skin Grafting.**—The surface to be grafted should generally be covered by healthy granulation tissue. The grafting of a fresh wound is more uncertain on account of the likelihood of the graft being raised from the surface by exudation or blood.

Epidermis Grafts—'Thiersch's Method.'—Strips of epidermis only are shaved off by means of a razor, which cuts through merely the tips of the papillæ. The epidermis of the arm and thigh, where it is free from hair, is the most favourable. The skin is made tense with the left hand or by the hands of assistants, the razor is then wetted with sterilized water, and the strip cut by drawing from the heel. The strip should fold on the blade of the razor, and so be carried to the raw surface and straightened out. If small, the whole surface is covered; if large, the strips may be laid, so as to cut up the whole area into a number of smaller ones. Over the strips should be laid green protective, and then a single layer of open gauze.

No antiseptics should be employed. The protective and gauze need not be changed until the grafts are fixed, but the discharges are syringed away daily through the meshes. The grafts which live soon become vascularized; any which fail are replaced by fresh ones. The new skin is at first delicate, and requires special protection. Later on, it becomes firm, soft and supple, very different from a hide-bound scar. When convenient, skin from which all subcutaneous tissue, and especially fat, has been removed, may be used instead. It may be obtained from an amputated limb, or from the prepuce of a healthy child. A piece of the patient's own skin may be transferred, but the epidermal grafts are now generally employed.

3. **Plastic Operations** are less often used now that epidermal grafts are so easily applied. A flap of skin is raised and turned over the area to be covered in. The flap retains its circulation through a pedicle. The commonest shape for the flap is that of a pear, which is especially useful on the face. A pattern is made of the area to be covered, and the flap cut $\frac{1}{4}$ inch outside the margin of the pattern, to allow for the shrinkage of the raised skin.

CHAPTER X.

SURGERY OF MUSCLE, TENDON AND CONNECTIVE TISSUE.

Rupture of Muscle and Tendon.

THE muscle fibres retract on rupture and leave a gap. If extensive, permanent weakness results owing to these fibres being no longer tense, and so unable to contract strongly. Important muscles when wounded should be always united by deep sutures. If the biceps or quadriceps be subcutaneously ruptured so that the major portion of the fibres are torn, an incision should be made and the torn ends united.

Abscess in Muscle.

If the abscess is confined to the belly of the muscle, the shape of the swelling is characteristic. An acute septic abscess will soon tend to spread beyond. A tubercular abscess may remain for long confined within the sheath, *e.g.*, of the psoas muscle.

Painful Spasm of a Muscle—Tic-douloureux.

The muscles of the face and neck are the more commonly affected.

The source of irritation must be sought for, *e.g.*, a bad tooth or enlarged gland is removed. Failing this, nerve-stretching or resection or avulsion may be done.

Cramp.

Aching pains and stiffness in muscle arise from anæmia and muscular exhaustion in overworked girls. Rest, tonics and massage form the treatment.

Severe forms of cramp are occasioned by partial arterial obstruction, and come on after slight exertion.

Sudden cramp or violent muscular spasm may attack a bather. Cold and exhaustion are the causes; even expert swimmers are often suddenly attacked. The person is rendered absolutely helpless, and must drown if left to himself even in shallow water. When pulled out, rubbing and artificial respiration must be immediately begun.

Induration of Muscle.

Muscular induration is frequently syphilitic in origin, as indicated by the history or other signs, confirmed by the administration of iodide or mercury. A chronic induration and contracture is the result of an interstitial myositis, which may be excited in the hand and forearm by venous congestion from tight bandaging. Removal of the bandages and persistent gentle massage and passive movement relieve, unless the muscular fibres be degenerated, when no treatment will avail.

Dislocation of a Tendon.

A tendon, especially about the ankle, may be displaced from a groove by a sprain or crush. It can be reduced by pressure with the thumb, but should the displacement recur, the tendon is exposed and fixed in its sheath by sutures.

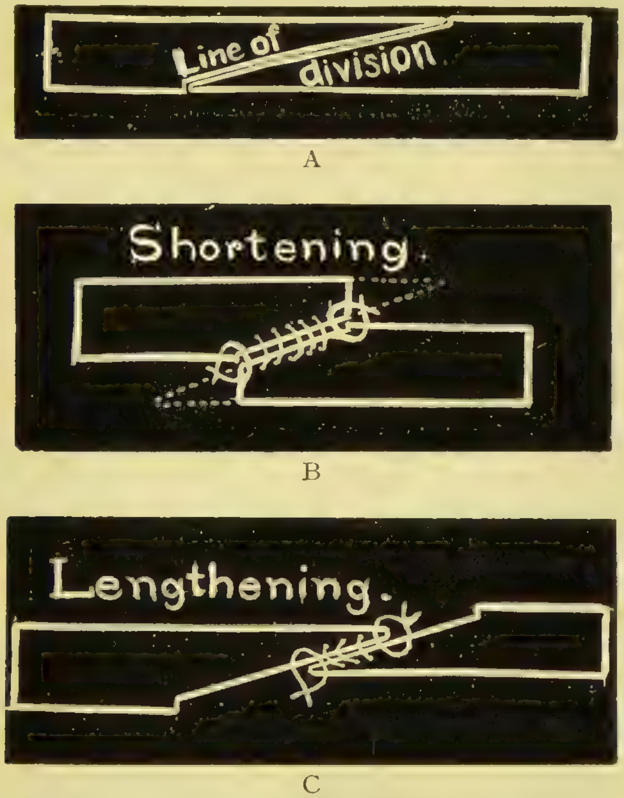
Contractures of Muscle and Tendon—Tenotomy.

Subcutaneous tenotomy was formerly more largely used than is now the case, but is still useful for division of tendons about the ankle, especially the tendo Achillis and the posterior tibial tendon. A narrow knife is used, and a puncture is made over the tendon. The edge of the blade is applied to the tense tendon, then, guided by the fingers and thumb of the left hand, the tendon can be cut through without any further injury to the skin. The pointed tenotome may be exchanged for a blunt-topped one after the puncture is once made.

But subcutaneous operations have lost their importance since the introduction of antiseptics, and if there are adjacent structures which can be easily damaged, much more harm is done by working in the dark. Hence in most cases the tendon is exposed by an open incision, and is carefully divided in full view. This applies to the division of a hamstring, where the popliteal nerves are liable to injury; to division of the sterno-mastoid tendon, where the jugular vein is liable to be punctured; and to division of bands about the hip, etc.

The Lengthening and the Advancement or Shortening of Tendons (Fig. 51, A, B, C).

When a contracted tendon lies in a sheath, the effect of simple tenotomy is that the upper end retracts. No union takes place, and the muscle is put out of action. A shortened tendon is divided obliquely, so that the cut ends glide on one another and lengthen the tendon, whilst the actual separation of the ends is prevented by suture.



A

B

C

FIG. 51.—SHORTENING AND LENGTHENING OF TENDONS.

In a similar way a tendon which has been unduly stretched can be shortened. As much as is necessary is cut out by oblique incisions, and the two ends united.

Tendon Grafting.

A destroyed tendon may be replaced by splitting a neighbouring one, or by grafting in one just cut out of an animal.

Tendon Sheaths.

Acute Inflammation in a Tendon Sheath.—Acute tenosynovitis is due to the over-use of a muscle when not in training, or it may be set up by the extravasation of blood produced by an injury. Very palpable and audible creaking is perceived on movement. It usually subsides on the application of cold lotions and rest, followed by gentle movement and massage. The inflammation may become chronic and form a ganglion. Acute septic inflammation and suppuration is secondary either to a septic wound or by extension of an abscess, and a free incision is at once necessary.

Simple Ganglion.

When tenosynovitis becomes chronic, fluid is liable to be encysted and so shut off from the rest of the sheath. The exudation causes a bulging generally towards the superficial aspect. The cyst contains at first merely inspissated synovial fluid, a semi-fluid gelatinous substance resembling the white of an egg. It may also contain the remains of blood-clot, little fibrinous masses like poppy-seeds or rice-grains. Chronic tenosynovitis is treated by applications of iodine. When a cyst has formed, excision should be done, the cyst wall being dissected from the tendon. An old but uncertain method is to rupture the cyst by thumb pressure, or by a sharp blow with the fist or back of a book in the hope that absorption may follow, but it is apt to extend the mischief. Tapping with a trocar and the injection of iodine rarely cure permanently, and extensive suppuration has often been set up.

Compound Ganglion.

In young people disposed to tubercular disease, chronic tenosynovitis or a simple ganglion tends to become tuberculous. The synovial membrane is swollen, œdematous or pulpy, owing to tubercles which can be seen under the microscope. Extension takes place widely in a tendon sheath, or involves several sheaths when the synovial membranes communicate. Caseation and suppuration ultimately take place. Therefore, all the diseased synovial membrane must be scraped away at an early stage, and the wall treated by a strong antiseptic.

Bursæ.

The ordinary bursæ are the ones usually diseased, but any adventitious bursa may be similarly affected.

Acute Bursitis.—Acute inflammation of a bursa is generally traumatic in origin, due to a blow or to friction; less often it is a rheumatic affection. The cavity is distended by serous fluid, which may become absorbed when the inflammation has been checked. Cold is applied, and if there is much tension, some fluid can be drawn off by aspiration.

Chronic Bursitis.—Chronic inflammation causes increase in the size of the bursa, and where the bursa is over a bony prominence, a growing thickness of the wall until the tumour becomes almost solid with a very small cavity within. Bursæ about a joint, such as the knee or shoulder, often communicate either primarily or secondarily with the joint, and, without any marked thickening of the wall, extend by prolongations between the muscles, forming intermuscular cysts.

Hæmorrhage occurs into a bursa, and the remains of the blood-clot form fibrinous masses which keep up a chronic inflammation.

Suppuration of a Bursa.—The wounding of a normal bursa by a septic puncture causes an acute œdematous inflammation, and has to be relieved by a free incision; suppuration and sloughing may also arise in a bursa whose wall has already become much thickened.

All diseased bursæ require excision, the edge of the knife being kept close to the cyst wall.

Connective Tissue.

Hæmatoma—A hæmatoma is caused by the extravasation of blood as a consequence of an injury. Inflammation is set up around, so that the blood-clot becomes encysted. The blood pigment is absorbed, and the colour of the overlying skin is first red, then blue, and finally yellow. The fluid may also be absorbed, or remain and form a blood-cyst. If not absorbed, laminæ of inspissated blood-clot may be found enclosed by a thick layer of connective tissue. A hæmatoma frequently suppurates, especially in young children, presumably from septic organisms reaching the hæmatoma through the circulation. Should this happen, the hæmatoma is incised, the blood-clot turned out, the vessels tied, and the cavity filled with gauze. If there is already a thick cyst wall, it is cut away.

Œdema.—Œdema is of obstructive or of septic origin, or both causes act in combination. For simple œdema fomentations and massage may suffice to obtain absorption, or multiple punctures may be made with a narrow knife.

Cellulitis.—This is a diffuse suppuration in connective tissue, as distinct from an abscess, which is circumscribed. It is characteristically produced by streptococci, especially those of erysipelas and allied diseases. There is first a septic œdema, *i.e.*, an exudation of cells and fluid, which quickly spreads along the planes of connective tissue and by lymphatics. The cells rapidly die and form pus cells, hence multilocular abscesses. Incisions must be made at once.

Surgical Emphysema.—Surgical emphysema is produced by a wound communicating with the respiratory tract, by which air is pumped into the tissues during expiration. It is, therefore, seen in wounds of the nose and its accessory sinuses, of the trachea, bronchi and lungs. It often spreads widely. Thus, after a punctured wound of the chest, or when the lung has been injured by fractured ribs, there is great swelling, extending even to the neck and head, and a crackling sensation is experienced on palpation. Although surgical emphysema frightens the patient and his friends, no danger need be anticipated, as the air expelled from the lung is aseptic, and is absorbed in a day or two.

Septic Emphysema.—Gas in the tissues is produced by the rapid development of gas-forming organisms, which gain entrance to the connective tissues owing to the rupture of gangrenous intestines, or to the extravasation of urine. It is regularly produced in the development of an anthrax pustule and spreads with the extension of the organisms. It also complicates phlegmonous erysipelas and gangrene. The process rapidly spreads in healthy tissues not exposed to the air, whilst the patient suffers from septic absorption. The progress of the emphysema is easily arrested if only it can be freely exposed to the air by an incision. If this cannot be done, and the trunk is involved, a fatal result is inevitable. Therefore, in the case of a limb, amputation above the spreading zone may be necessary.

Contracture of Fascia.—A band of fascia contracted by inflammation may be stretched by slow extension, divided by one incision, or by several small punctures, or excised.

Tumours of Connective Tissue.

Gummata are common, and a differential diagnosis often difficult. The administration of iodides generally serves as a means of identifying or of excluding them. However, antisyphilitic remedies of the most vigorous kind may fail to remove a gummatous mass which may then be excised.

Fatty Tumour or Lipoma.—The encapsuled lipoma generally commences in the deeper layers of the skin (see p. 101). Occasionally a lipoma is met with in intermuscular connective tissue, or growing from subperitoneal or subpleural fat or from periosteum. Such lipomas may consist partly of nævoid or of fibrous tissue.

Diffuse Lipoma (Lipomatosis).—Diffuse lipomas are not encapsuled, are generally multiple, often symmetrical, are more doughy and not lobulated. They occur in patients who have taken alcohol, although not necessarily to excess. They consist of a diffuse overgrowth of the subcutaneous fat, especially over the nape of the neck, behind the ears, under the chin, also over the breasts, abdomen, genital region, or on the limbs.

The points which render diffuse lipomas generally unsuitable for removal are the degenerated condition of the patient's tissues, and the liability to erysipelas. Also the tumours are markedly vascular as compared with the true lipoma, and are not circumscribed, but fade insensibly into the adipose connective tissues. Diffuse lipoma is treated by improving the patient's health, limiting alcohol, and administering iron, for there is generally anæmia. Arsenic is also an important remedy, and sometimes acts remarkably well in reducing the fat. In addition, when present, general obesity requires treatment. But when a lump of fat incommodes the patient and prevents him from work or taking exercise, the skin is turned back and the mass cut out.

Fibromas are, next to lipomas, the commonest among the benign tumours of connective tissue. Their fibrous structure may be very dense or be quite soft, or be combined with fat.

Chondromas, Osteomas, Angiomas.—These are the less common benign tumours, consisting of cartilage, bone, or a plexus of bloodvessels, more or less combined with fat and fibrous tissue.

Sarcomas are connective-tissue tumours, composed of an embryonic type of cells, round or spindle-shaped, with fibrous tissue. Excision is always required whenever possible. This is impossible when a single tumour has already spread too widely, or when the growth is a multiple one.

Cysts in Connective Tissue.

Parasitic Cysts are rare. *Cysticercus cellulosæ* is more frequently seen on the Continent than in this country. They form tense little swellings, out of which the cysticercus escapes on puncture. Multiple cysts becoming pedunculated have been seen resembling superficially mollusca fibrosa.

Echinococcus cysts are met with in countries like Australia, and are recognised by the white cell wall, the clear fluid, the daughter cysts, and the hooklets.

The cyst wall separates easily, and should be removed intact unless inflammation has occurred. Then the white nonvascular parasitic cyst becomes adherent to the adventitious cyst composed of vascular connective tissue, from which it has to be removed by scraping.

Epithelial or **Dermoid Cysts** are lined by skin containing a great number of sebaceous glands, and in some cases hair. They are common on the scalp, where they never contain hair nor teeth. A small one is seen in children attached to the periosteum above the outer angle of the orbit. Dermoid cysts occur in the broad ligaments, in connection with the ovary, and may contain not only sebaceous material, but also hair, teeth, bone. They are liable to suppurate, also to become malignant; sometimes they get separated, and adhere to the omentum, mesentery, etc. Dermoid cysts are met with in the testis, in the wall of the bladder, or between it and the rectum. These latter may contain a yellowish fat, fluid at the body temperature, which sets on cooling. Dermoid cysts occur in the thorax, especially in connection with remains of the thymus gland.

Branchial and thyro-glossal cysts form in the neck, the former in the remains of the branchial clefts, the latter between the isthmus and the foramen cæcum.

Epithelial implantation cysts occur especially on the fingers, but also on the foot and elsewhere, owing to bits of epithelium displaced into the connective tissue by a small cut. They are lined by epithelium, but sebaceous glands are not present, nor hair. A cut of the eyelid has penetrated the cornea, and planted a cilium on the iris.

Glandular Cysts are connected with the skin or mucous membrane, to which they remain attached, although they encroach upon the connective tissues. They are obstruction cysts, in which the duct is plugged by inspissated material, and the alveoli are distended by the more or less altered secretion. (Sebaceous Cyst, see p. 100.)

Mucous cysts arise from buccal glands on the lip; ‘ranulæ’ form beneath the tongue from salivary glands; the parotid, pancreas, etc., are distended by mucous secretions.

In the mammary gland milk cysts form.

Connective-Tissue Cysts.—Congenital cysts are met with in the neck, less often in the axilla, groin, or kidney region, owing to a distension of connective-tissue spaces. Cysts also arise in connective tissue from lymphatic obstruction. A cyst may represent an incompletely absorbed hæmatoma, or be an adventitious bursa, due to the inflammation and exudation caused by rubbing over a bony prominence.

All cysts require to be excised completely; if not, they suppurate, or ultimately — especially in the case of the epithelial cysts—become new growths.

Degeneration Cysts.—Fibrous and cartilaginous tumours undergo myxomatous degeneration, so do adenomas, *e.g.*, of the thyroid gland, parotid, etc. Cysts also form in malignant growths, both sarcomas and carcinomas.

CHAPTER XI.

FRACTURE AND DISLOCATION.

A FRACTURE, *i.e.*, solution of continuity in a bone, is only a part of the damage done; there is always some bruising or sprain. The same is the case with a dislocation. Mechanical injury may cause a bruise only, and muscular violence short of producing a fracture or dislocation originate a sprain.

Bruise or Contusion.

When the subcutaneous tissue and muscles are lacerated, the bloodvessels are also torn, and blood infiltrates the injured part and the loose connective tissue around. The blood-clot sets up some inflammation and the formation of scar tissue, hence rigidity.

Sprain.

A sprain includes the stretching or rupture of ligaments, the tearing of tendon sheaths, with their vascular synovial membranes, the separation of a tendon, partly or completely, from the belly of its muscle, or from the bone to which it is attached. The ligaments and synovial folds of a joint being torn, blood is extravasated, and traumatic arthritis excited. In consequence, adhesions form between tendon and tendon sheath, or between joint surfaces, and so there is limitation of movement.

The bruising and the sprain which accompany a fracture or dislocation, as a matter of fact, often require the more attention, and their treatment has to be continued for a long period.

Fracture of a Bone.

A fracture is usually a complete solution of continuity. In children, however, it is often the case that a part only of the section of bone is actually separated; the rest is crushed together, as in the bending of a green stick. The 'green-stick' fracture is most commonly seen in the clavicle. Other instances of incomplete fractures occur in the skull, especially the fissured, indented, or punctured fractures produced by sharp instruments.

Subcutaneous Fracture.

In this case the skin is intact, and the injury, both of the bone and soft parts, heals as an aseptic wound. The fracture is generally called 'simple' in this country, but complications may be many, such as comminution of the fragments or injury to neighbouring structures, such as the blood-vessels, and, above all, union in a bad position.

Open Fracture.

The essential characteristic is the lesion of the skin to a greater or less extent, so that the line of fracture is open to the air. The whole wound will, except when the skin is only punctured, become septic, and suppurate, unless treated by antiseptic methods. The fracture is called 'compound' because compounded of two quantities, the skin wound and the fracture. It is also called 'complicated.' But 'open fracture' is the best name, and if well treated the fracture may heal as quickly as a subcutaneous one, without any complications whatever.

Complications of a Fracture.

According to the kind of violence and the structure of the bone injured, the line of fracture is transverse to the long axis, or oblique, or longitudinal, so splitting the bone, or spiral when the bone has been violently twisted. The transverse is the easier to keep in position, the oblique the more likely to be followed by shortening, unless the muscles are kept extended. Longitudinal and spiral fractures may more extensively injure a bone than appears on the surface. After a partial or complete fracture the violence may continue, and drive the fragments into one another, so that the ends become more or less firmly wedged together, or impacted. In young people the separation may take place at the epiphyseal line, attended by considerable extravasation of blood, owing to the vascularity of the growing bone.

The important complications of a fracture, whether subcutaneous or open, are: dislocation, fracture into a joint, rupture of the large artery of the limb. Fractures of the skull and spine have their special complications in connection with the central nervous system.

The Evidences of a Fracture.

1. There is a loss of power in the limb, so that the patient cannot make active movements; nor can he resist the passive movement of the limb, however painful that may be. Some power of active movement is retained if only one bone of the forearm or leg is fractured, or in the case of the femur or humerus if the fracture is impacted. A non-impacted fracture of the femur or humerus, and fracture of both bones of the forearm or leg, are attended by entire loss of power in the injured limb.

2. Distortion of the limb from the level of the fracture downward. This sign may not be found in some cases of fracture of one bone of the forearm or leg, but it will be seen in impacted fractures. In most cases there is shortening, except when the fracture is incomplete, or transverse but without displacement.

3. Pain and swelling. Marked pain, localized in a certain spot, and increased by pressure, not only over the bone at the spot, but also by pressure on the bone above or below, adds to the probability of a fracture without displacement, *e.g.*, in an obscure case of injury to the forearm or leg.

Swelling and ecchymoses must be considered in relation to the tissues. Thus, they may not be found when tense unruptured fascia covers the fracture, but when bruising is in excess, it indicates that severe violence has been applied to the limb, and therefore that a fracture is all the more likely.

This refers especially to injuries about the shoulder or hip-joint.

4. Preternatural mobility, and crepitus from the rubbing of the ends on one another, are signs diagnostic of a fracture. They can generally be obtained by the gentlest manipulation; even light pressure is often quite sufficient. A surgeon ought to be able to assure himself of a fracture without further hurting the patient. It is very wrong to pursue the search after crepitus with unnecessary zeal; no prolonged attempt to find it ought to be made lest further injury to lacerated parts be caused. In many cases the fracture is perfectly obvious from the other signs; all that should then be done is the one movement necessary to reduce the fracture into position, and the hand which is resting on the site will feel the bones slip into position as extension is made with the other hand.

Reduction of a Fracture.

In all cases of severe fracture the patient should be anæsthetized whilst the limb is being reduced. But even then no great attempt should be made to obtain crepitus, for just as much damage can, of course, be done, even although the patient does not feel it.

Reduction of a fracture is carried out by making extension on the limb with one hand, whilst with the other the distal fragment is pressed into position. The simplest forms of displacement are reduced by bringing the limb below the fracture into line, and overcoming any transverse displacement. The more difficult forms to overcome are rotatory, overriding, and impacted displacements. If the impaction is in a distorted position, force must be used to separate the ends, except in the case of old and feeble patients, in whom the impaction should be let alone. Some fractures cannot be kept in position, or cannot be brought into position, because of muscle, fascia, or comminuted fragments which have been interposed. An attempt must be made to free the ends by moving them on one another. The necessity of cutting down upon such fractures and freeing the ends is now recognised. A badly united or ununited fracture may ruin the prospects of the patient, and pauperize both him and his family, whereas the exposure and fixation of the fracture may be done safely if antiseptic care be taken.

Special Treatment of an Open Fracture.

An anæsthetic is generally administered. A pad of wool soaked in 5 per cent. carbolic acid is placed on the wound without attempting reduction for the moment. Then the whole limb is shaved, washed with soap and hot water, and rubbed with turpentine or ether until all the skin is perfectly clean, after which the wound is attacked. If only a small puncture, the end of the bone is swabbed freely with the carbolic acid before its reduction; when widely lacerated, all the dirt and blood-clot are wiped out, epidermal bullæ are laid open; all pockets are most carefully sought for and cleaned out, incisions being made in order to reach their ends, for otherwise the blood-clot will certainly break down, and give rise to prolonged suppuration; arteries which bleed are tied or twisted; muscle and fascia are separated from the ends of the bone, which are restored to exact apposition, and comminuted fragments are laid down in place. If there is much mobility, sutures of wire or silk may be inserted, so as to hold the fragments in apposition, or ivory pegs or steel nails may be used. Finally, the skin is sutured, except for drain openings, and dressed. When suppuration has already set in, the same course should be adopted, all pockets being laid open and scraped, after which the wound is filled daily with gauze. The fixation apparatus must be so applied that the dressings can be changed without disturbing the limb, and the discharges must not collect and decompose on the splint. Massage and passive movement are begun above and below the wound as early as possible, and over the wound as soon as it has healed.

Predisposing Causes of Fracture according to Age.

Children in whom the bones are still soft suffer from 'green-stick' fractures; in childhood and youth, up to puberty, separation occurs along the line of junction between the epiphysis and diaphysis. In adults, the kind of occupation is of special importance in the case of men. In old age the atrophy of bone from diminished muscular activity is specially noticeable as predisposing to fractures in women.

Pathological Fractures.

A pre-existing disease so weakens the bone that a fracture occurs without any violence in the course of some ordinary movement. Fœtal bone disease is especially characterized by the imperfect formation of cartilage and bone, and causes multiple intra-uterine fractures. They must be distinguished from those fractures which occur during birth from direct violence. Scurvy, rickets, and cretinism cause pathological fractures in infants and children. There is seen a peculiar fragility of bone leading to multiple spontaneous fractures without any further evidence of disease. It is often seen in several members of the same family, especially in girls about puberty. The enforced rest, and the deformity resulting from this fragility, causes atrophy of the bone, and so makes the condition worse. Local disease of bone, inflammation, abscess, syphilis, and tubercle, either by actually destroying bone, or by promoting atrophy of muscles and bone, after a joint has been diseased, are causes of pathological fractures. General diseases, causing degeneration of the nervous system, such as insanity, locomotor ataxia, syringo-myelia, and senile decay, also malignant disease, whether local or a generalized cachexia, and mollities ossium, increase the fragility of bone.

The patient has to be treated as in the case of an ordinary fracture as regards the fixed apparatus, which may have to be worn for a long time. It is remarkable that although there may be excessive fragility of bone, yet abundant callus causing firm union often occurs. Cases of malignant and other local diseases may be suitably treated by amputation. Mollities ossium may be arrested, so that the bones harden up again, if the ovaries be removed—at any rate, in the case of women who are still some years from the climacteric.

Dislocation.

A dislocation is either complete—*i.e.*, the joint surfaces are entirely separated—or some portions of the cartilaginous surfaces still remain in contact, and this constitutes a subluxation. A complete dislocation is attended in almost all cases by a rupture of the capsule; this need not be the case in a subluxation—indeed, some loose-jointed persons are able to subluxate a joint at will. An internal dislocation, similar to subluxation, occurs in the knee and temporo-maxillary joint owing to a displacement of the interarticular cartilage.

A dislocation is generally subcutaneous or simple, and rarely open or compound, except in the case of the phalanges, in which a dislocation is usually accompanied by an open wound. Of great importance in relation to treatment is the fact as to whether the dislocation is recent or of long standing, whether it is accompanied by a fracture or not.

Evidences of a Dislocation.

The distinguishing signs of a dislocation are:

1. Loss of mobility, both to active and passive movement. Generally there is at first loss of all active movement, and only with some force and in certain directions can passive movement be obtained. After a time some slight amount of active movement is regained, although the dislocation remains unreduced. Anæsthesia does not restore free passive movement before reduction.

2. The altered relation of bony points to one another, and especially the absence of the head of the bone from the joint, and its presence outside. This sign is easily perceived immediately after an accident, but it may be soon obscured by swelling.

3. The altered direction of the axis of the limb below. This necessarily follows from the altered position of the head of the bone, except in the cases where fracture is also present. It is valuable as a sign of dislocation when the position of the head of the bone is obscured by the swelling.

Relative Frequency of Dislocations and the Relation to Age.

Dislocations about the elbow are most frequent before and soon after puberty, indeed, other traumatic dislocations are very rare. During middle life, up to sixty, by far the commonest dislocation is that of the shoulder. Dislocations of the ankle are nearly always combined with fracture, and are classed under that heading. Dislocations of the metacarpo-phalangeal joints, especially that of the thumb, and dislocations of the lower jaw, are common, and the latter in women is the commonest instance of dislocation by muscular violence.

The subluxations of the knee, including the displacement of the semilunar cartilages, are frequent, whilst complete dislocations are rare. Dislocations at the hip-joint have been the subject of many experiments upon the cadaver, and so attention is given to them in books out of proportion to their relative frequency. They are far less common than the fractures of the neck of the femur and the dislocations of the shoulder. Dislocations of the spine are nearly always combined with fracture.

Reduction of a Dislocation.

Dislocations are replaced by making the head of the bone travel back into the joint the way it came. By so doing it passes in through the hole in the capsule it made in leaving. The information as to methods has been gained empirically in practice, by the dissection of old dislocations, and by experiments upon the cadaver, these latter methods consisting partly in using the limb below as a lever to act upon the head of the bone, and partly by making direct pressure upon the displaced head of the bone itself.

Muscular contraction is overcome by extension or by means of an anæsthetic.

For reduction it is best to use manipulations, and not to employ any great force. The objection to the latter expedient is the danger of fracture of the bone, of tearing muscles and tendons, so rendering the limb weak, or of rupturing an artery and causing an aneurysm.

The failure to obtain reduction after inducing anæsthesia is generally due to the displacement of the capsule or of muscle, so as to separate the head of the bone from the rent in the capsule. The head of the bone may in some cases be thrust through a muscle or tendon, which then holds the head like a button in a buttonhole. The older the dislocation, the more the contraction of muscles; besides which there is the closure of the hole in the capsule, the formation of a depression in the new position of the head, and the filling up of the old joint cavity.

Supposing the failure to obtain reduction without or with an anæsthetic, using only moderate force, then an incision for the replacement of the head is indicated, and this is the measure now generally employed for an old-standing dislocation.

After-Treatment of a Fracture or Dislocation.

The treatment of a case after reduction of a fracture or dislocation entails the suitable combination of two opposing methods.

1. **Restoration of Movement.**—Rapid removal of the inflammatory products by massage, and early passive movements, continued until active movements are re-established.

The great aim is to obtain the early restoration of active movements, unimpeded by inflammatory adhesions of the tissues to one another. The difficulty of application lies in the pain occasioned by the injury, by the mobility of the fragments, or by the tendency to redislocation.

As soon as possible after an accident the limb is placed on a cushion in the most comfortable position. Then massage is commenced in one of three ways: stroking with the thumb and fingers, always in the direction of the venous and lymphatic circulation, parallel to the muscles and tendons; circular movements—movements encircling the limb—with the palmar surface of the hand and fingers; rotatory movements, as of a pestle in a mortar, using the palm of the hand, with the fingers extended. Olive-oil is used as a lubricant, or soap-lather, if a smoother surface is required. The first sitting must be extremely light, only the most delicate pressure is made. The one criterion of success is the absence of pain; on the contrary, there should be relief. Gradually firm stroking and pressure can be used, so that tendons and muscles can be displaced from side to side by the thumbs.

At first the massage is above or below the site of fracture, then over it. This is combined with passive movements, including those of the neighbouring joints, whilst active movements are encouraged. A light fixation apparatus is applied between the sittings.

For bruises, sprains, doubtful fractures, and fractures without mobility, this treatment can be begun from the first, and thereby recovery is much hastened.

2. **Rest.**—The injured limb is retained in a fixed apparatus after reduction until the fractured ends have united and the pain and swelling have subsided. This is necessary where the fractured ends are very mobile, as in fractures of the shaft of the humerus or femur, or where there is a liability to redislocation, as of the shoulder. The great objection to the treatment by rest is the long period of uselessness to which the limb is condemned even after the bones have united, and the inability of the patient to follow his occupation. The prolonged pain, swelling, and weakness of a limb after the union of the bones are due to the inflammatory adhesions of the various tissues to one another, which, when once formed, are only very slowly or imperfectly resolved. A slight injury, such as a sprain, if treated by prolonged fixation, may be the means of rendering the limb useless for a term as long as if there had been the severest fracture.

Even with the most mobile fractures, massage can be begun during the second or third week at the latest, and the fixation apparatus reapplied between the sittings.

Fixation Apparatus.

The simpler forms of apparatus, such as can be adapted to suit most cases, are generally employed. A more complicated apparatus, requiring the skill of the instrument-maker, and careful fitting, is reserved for chronic and exceptional cases.

Sand-bags and Cushions.—The limb can be laid in a hollow made by sand-bags or cushions. A light sand-bag placed across the limb prevents painful muscular twitchings.

Splints should generally be made of wood, and of a simple kind, such as any carpenter can cut out. They must be

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broad enough to protect the limb from the pressure of the bandage, be well padded, and if there are discharges, or an ice-bag or fomentations has to be used, the padding must be covered with a rubber sheet. Splints can also be made of soft sheet-iron or tin. They can be moulded to the part out of porous felt, which is softened by steam, or of leather, guttapercha, or cardboard, softened by warm water. The guttapercha is best if there are discharges.

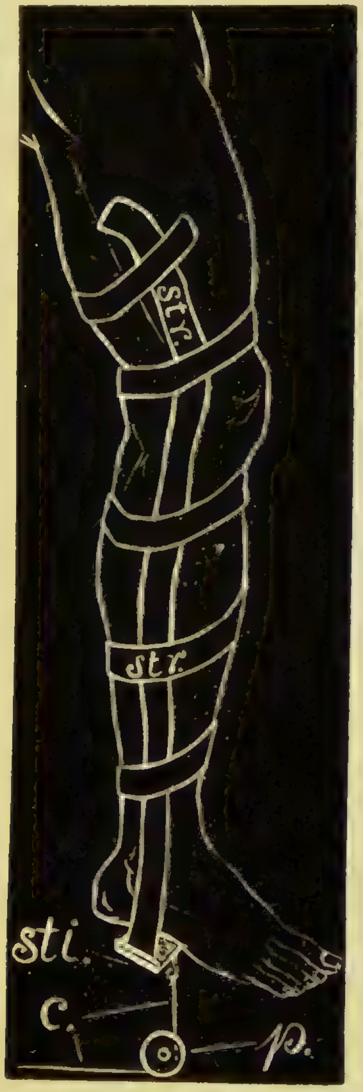

FIG. 52.—EXTENSION BY WEIGHT.
str, Strapping; *sti*, stirrup; *c*, cord; *p*, pulley.

Gooch's splinting consists of thin strips of wood held together by leather pasted over one surface.

Extension is generally required only in the case of the lower limb; in the upper extremity the weight of the distal portion suffices, as a rule, to counteract muscular contraction. Extension is made by applying a strip of strapping on either side of the limb, and keeping them fixed by a third strip wound over them in a spiral. The strips are attached to a weight by a stirrup and cord over a pulley, or to a rubber ring (Fig. 52). Counter-extension is made by raising the foot of the bed, so that the patient shall not slip down; occasionally by loops under the armpits, ending in a cord and weight at the head of the bed. The weight required, *e.g.*, for a fractured femur, varies from 4 pounds in the case of a child, up to 10 pounds for an adult; but 20 pounds, or even 30 pounds, may be required to overcome muscles, especially when extension is applied late.

Durable Bandages.—The ordinary cotton bandage will last longer if covered with starch paste. But the commonest, and best, is made by rubbing fine dry plaster of Paris into strips of crinoline muslin. The plaster should be dry, and in a fine powder. It must be well rubbed into the muslin by the hand, and the strip rolled up quite loosely, so that water penetrates throughout immediately the bandage is dipped in. The limb is first enclosed in a flannel bandage. One made by tearing a sheet of cotton-wool into strips serves for young children, or for covering the site of a fracture, bony prominences, or a joint into which effusion is anticipated. The plaster bandages are dipped into cold water, which should at once soak them through, and are immediately withdrawn, and applied quickly, without squeezing out the plaster. Spiral or figure-of-eight turns are used, and the free hand smooths down behind the roller. About three layers suffice. The plaster sets almost at once, and dries in about two hours. It can be trimmed or cut down the front and back with a pruning-knife or special shears, and so removed for massage and dressing, then re-applied, and fixed by webbing and buckles, or a bandage.

A Bavarian splint is made by sewing together down the middle two sheets of house-flannel. The inner sheet is fixed round the limb by thread or pins; over the outside is spread a layer of plaster of Paris, made into a paste, and over this the outer sheet is drawn tight and pinned. When dry, the splint can be taken off by cutting the threads in front, then it opens by a hinge along the line where the two sheets are stitched together. The surgeon's hands may be covered beforehand with vaseline, and the nails filled with soap; in washing off the plaster, cold water should be first used, brown sugar will aid the removal. The plaster bandages are removed from the patient by first soaking them in hot water.

A silicate bandage is a loose roller bandage of crinoline muslin soaked in liquid glass, silicate of potash. This bandage takes about a day to dry; it is somewhat lighter than plaster of Paris, and is applied in the same way.

Combinations of splints and durable bandages are frequently employed.

Obscure Cases of Fracture and Dislocation.

In order to make a correct diagnosis, and adopt the proper treatment, it may be necessary to observe the patient for a few hours or days, the injured limb being meanwhile accommodated between sand-bags and pillows, during which recovery from shock and a return to the normal circulation in the limb may take place. The swelling about the injury may become less, and a more accurate history of the accident may be obtained. A skiagraph will show any alteration in joints or bones. The surgeon, after this delay, is then fully prepared either to reduce the deformity under an anæsthetic, or to proceed at once to divide all obstructions through an incision, and to fix the bones in their proper position.

Congenital and Pathological Displacements.

A true dislocation due to injury is to be distinguished from so-called 'congenital dislocations' and 'pathological dislocations.' A congenital displacement is due to malformation of the joint surfaces, from which a dislocation occurring during birth must be sharply distinguished. Displacement from disease is diagnosed by the history of the case and by special signs of disease.

CHAPTER XII.

BONES AND JOINTS.

Inflammation of Bone—Periostitis and Ostitis, Epiphysitis, Osteo-myelitis.

Simple traumatic inflammation due to bruising quickly subsides under the influence of rest and cold, but an injury is an important factor in exciting syphilitic, tubercular, or septic inflammation, and occasionally sarcoma.

Syphilitic Inflammation affects at first the periosteum, and then extends to the bone. The inflammation is subacute or chronic, and is always attended by pain, especially at night. As a result of the inflammation, an increased ossification occurs at the periosteum, producing a node, *i.e.*, a sclerosis of bone, in which the cancellous tissue is replaced by compact. An excessive rate of growth at an epiphysis may also be excited. Later on gummata form, which extend outwards and produce an ulcer, or cause necrosis of part of the shaft of the bone. Full doses of iodide of potassium and the local application of mercury ointment have an immediate effect in relieving the pain and inflammation. But these drugs fail when a late stage of ulceration or of necrosis has been reached, and then direct surgical interference is necessary.

Tubercular disease does not affect primarily the shaft of any of the long bones; its attack is confined to the epiphyseal and joint surfaces, and to the short bones. It commences by the formation of tubercles at the line of the epiphyses, or beneath the articular cartilage, followed by caseation and suppuration. Extension takes place by ulceration or caries towards the joint, or into the substance of a short bone like the ilium or scapula. In this stage tubercular disease is treated by fresh air, rest and tonics, including cod-liver-oil. When caseation and septic complications ensue, then tubercular disease of bone becomes a matter for surgical treatment.

Acute Primary Septic Inflammation is due to the introduction from without through the skin, or by way of the alimentary canal and the circulation, of pyogenic organisms. It attacks the most vascular part of bone, the periosteum of the shaft in a child, the epiphyseal end of the diaphysis of a growing boy. There is a rapid formation of pus, with necrosis of bone, extension to the medullary cavity, *i.e.*, osteo-myelitis, and a tendency to general septic infection through veins. The disease is surgical from the outset.

Subacute and Chronic Septic Inflammations supervene and complicate syphilitic and tubercular disease.

Puncture of Bone.

A bone may be punctured in any direction through the skin by boring with an awl. It serves chiefly to relieve congestion of bone, and may be a means of discovering a collection of pus. For the latter purpose the periosteum is first incised.

Incision of the Periosteum.

An incision is made for the relief of chronic congestion, for the evacuation of a breaking-down gumma, or of pus beneath the periosteum. In acute septic periostitis an incision must be made within a day or two of the commencement, or extensive necrosis, or general septic infection is likely. The incision must be long enough to expose the whole cavity, which is then scraped, and wiped out with an antiseptic.

Exploration of Bone.

After incising and retracting the periosteum, the bone itself is explored with an awl, by boring with a gouge, or by removing a disc with a trephine. On discovering an abscess cavity, the superficial wall must be removed for the whole length by means of a gouge or chisel ; the whole interior of the cavity is cleared out, and treated with a strong antiseptic, and then the cavity is plugged with strips of iodoform gauze. The strips are changed daily until the cavity is completely filled up. The whole medullary cavity of the femur has been scraped out through a long external incision, about a quarter of the circumference of the femur being removed; complete healing followed, and so the patient was saved from an amputation at the hip.

Removal of a Sequestrum—Sequestrotomy.

When necrosis has definitely taken place, there should be no delay, but the whole of the dead bone must be chipped away from the living, and the cavity dressed daily with iodoform gauze. The operation ought not to be put off until the sequestrum becomes loose.

Bone Suture.

Suture of bone is required for subcutaneous fractures whenever the fractured ends cannot be maintained in position, *e.g.*, after fracture of the patella; it may be used for open, especially comminuted, fractures where there is great mobility. It is needed for ununited fractures after refreshing the ends of the bone.

Silver wire is generally employed, either looped round, or passed through holes bored in the bone; the twisted end is hammered down flat. Ivory pegs or steel nails can be used in certain cases with advantage. If a hole is first bored, it must be slightly smaller than the peg which is to be driven into it.

Bone Grafting.

For closing in a gap in the skull, or for restoration of the bridge of the nose, it is best to use a pedunculated flap, which is first marked out by an incision through the soft parts, and then raised by means of a chisel, which separates the outer table from the diploe. The flap has thus the periosteum still attached to a thin layer of bone. Not only will new bone be formed in this way, but the tendency to reabsorption, which new bone produced by grafts is apt to undergo later on, is avoided.

Chips of periosteum and bone may be transplanted into the wound from a healthy young animal which has just been killed; and this is especially applicable to the case of long bones.

The formation of bone is favoured by slight inflammation, such as may be set up by injecting 10 per cent. zinc chloride

Osteotomy and Refracture.

The soft bones of a rickety child may be bent straight, and fractures not in good position may be likewise replaced before firm union has occurred. If a strain short of breaking be put on a bone, a week afterwards the same amount of force may be found capable of bending the bone, on account of the inflammatory absorption which has meanwhile gone on in the bone at the spot strained. Firm bones may be fractured subcutaneously by being put into a vice, or may be partly cut through by inserting a narrow chisel or saw through a small incision, the rest of the bone being fractured. The latter is the more exact method, and is free from all danger when done antiseptically. By forcible fracture in a vice the line of fracture may be uncertain, and an epiphysis may be separated instead.

Tumours of Bone.

Traumatic.—A hæmatoma is formed by the extravasation of blood between the bone and periosteum, causing a swelling immediately following upon an injury. Absorption of the blood, with disappearance of the swelling, takes place under rest and cold lotions. It must be distinguished from a fracture, and this is difficult when there is no displacement, and especially when only one of the bones of the leg or forearm is affected. The complications which may ensue are, the formation of a blood-cyst owing to imperfect absorption, or a chronic painful periosteal thickening, in both of which cases an incision is indicated. An injury may predispose the bone to an attack of septic inflammation and the formation of an abscess, or syphilitic infection may be localized by the injury, and periostitis, chronic ostitis, and sclerosis of bone, or necrosis, be set up. Septic inflammation is likely to occur about the epiphyses, syphilitic affection in the shaft of the long bones. But inflammation may be started at any point by a slight injury. In such cases an exploration is required—the boring the bone for relief of congestion, erasion of abscess cavities, gouging away dead bone. A trivial injury may start a sarcoma; a callus tumour, of local malignancy only, may be set up around an ununited fracture.

Cysts of Bone.—Hydatid cysts are occasionally met with. The parasitic cyst requires removal, and the cavity is filled with gauze. This should be done before a fracture has occurred. A cyst arises in the jaw in connection with a tooth. A blood-cyst as the direct result of an injury is seen beneath the periosteum. Blood-cysts of bone are generally myeloid sarcomata which have undergone myxomatous degeneration in the centre, and are recognised by a microscopic examination of the wall. A central blood-cyst including a pulsating aneurysm of bone must be assumed to be a myeloid sarcoma, and dealt with accordingly.

Exostoses and Osteomas.—Exostoses are bony tumours projecting from the surface of the bone. On the long bones they arise in the epiphyseal line, and become more and more mushroom-shaped, and are composed of cancellous bone. Whilst growing they are covered by a layer of ossifying hyalin cartilage, over which is a synovial membrane. They are most commonly seen at the lower end of the femur, and are easily removed by chiselling or sawing off the peduncle. Multiple exostoses appear in rickety persons, sometimes in more than one member of a family. They are more sessile than the single exostosis, and denser; other rickety changes are seen in the bones, and there is a considerable liability to the development of sarcoma after puberty. Multiple exostoses may be removed if they press on nerves or if the skin threatens to ulcerate. Exostoses must be distinguished from an exaggerated prominence for the insertion of a tendon, and from the ossification in tendon, which may be merely an anatomical variety or follow upon a sprain.

Exostoses of the sessile kind, and consisting generally of compact, ivory-like bone, grow on the upper and lower jaw, on the frontal bone, and in the external auditory meatus. They cause pain by pressure on nerves, especially those of the jaw, and also press on the brain when growing from the inner table of the skull. In the ear an exostosis is a cause of deafness and pain, and may lead to retention of discharges. The difficulty in the removal of sessile ivory exostoses is the hardness of the bone. A foot or electromotor dental engine is required, and then the base is bored through by a rapidly-rotating drill, or grooved by a circular saw; finally the separation is completed by a few blows with a chisel of hard steel. Thus a fracture of the skull from the violence of the blows is avoided.

Sarcomas of Bone.

Sarcomas of bone are distinguished by growing from the periosteum and superficial layers of the bone, or from the centre of cancellous bone.

Periosteal Sarcomas are of a malignant type, and rapidly extend throughout the whole bone and into neighbouring muscles. Then the growth spreads by lymphatics to lymphatic glands, also by veins, and there is very quickly a development of secondary growths. The structure of the tumour consists of embryonic cells, which are of a round, oval, or spindle shape. The slower the growth of the primary tumour, the more fibrous tissue (fibro-sarcoma), or cartilage (chondro-sarcoma), or bone (osteo-sarcoma), is likely to be developed. But these latter characters do not generally indicate any lesser form of malignancy, any smaller tendency to give rise to secondary growths. A periosteal sarcoma may degenerate and show mucoid tissue (myxoma), or form cysts containing serum or blood (cystic sarcoma).

A periosteal sarcoma can only be successfully removed in the early stages, within three or four months of its origin, by excising the whole bone; it is useless to remove a part only of the bone. When the sarcoma has extended beyond the bone into the muscles, the prognosis as to ultimate cure becomes much worse. The whole of such muscle must be removed. This means the amputation of the limb at the joint above the growth, or higher up In addition, the lymphatic glands connected with the part must be excised.

Myeloid Sarcoma grows from the centre of short bones and the cancellous ends of long bones. It is characterized by being included during the early stages by a shell of bone, within which is a tumour. The solid portion is of a brown or maroon colour, the colour of the heart. In addition, much blood becomes extravasated. Indeed, the whole cavity may be occupied by degenerated tumour and blood, surrounded by a thin layer of new growth. The myeloid tumour is further characterized under the microscope by containing amongst small oval and spindle cells numerous giant, multinuclear cells, like the giant cells of bone marrow. When these are found in any considerable number the benign type of the tumour is substantiated. A myeloid sarcoma grows slowly, and takes one to two years before it bursts its shell and invades the muscles, and it is only after a longer period still that any secondary growths arise. A myeloid sarcoma may be scooped out of its shell, or the bone excised just beyond the margin of the tumour. Even in advanced cases the limb need only be amputated just above the growth, and when the whole of the primary tumour is removed a cure may be confidently anticipated.

Inflammation of Joints—Arthritis.

I. Simple Arthritis with Serous Effusion.

Traumatic Arthritis.—An injury causes a bruising or tearing of the vascular synovial membrane, which is consequently suffused with blood, and blood is extravasated into the joint. This is followed by a rapid serous effusion. With rest and cold applications the acute inflammation passes away, otherwise subacute and chronic inflammation continues, especially when the blood-clot is imperfectly absorbed, and the fibrinous masses which remain act as foreign bodies, and keep up the inflammation. If a young patient has any tubercular tendency, or an adult past middle age a rheumatic one, tubercular or rheumatic inflammation is apt to be localized and set up in the joint as a direct result of the injury.

It is important to distinguish between an injury causing mainly a sprain with effusion into the tendon sheaths around a joint, and one causing mainly traumatic arthritis. In the case of a sprain, the proper treatment consists in movement and massage as early as possible; for traumatic arthritis, rest until the inflammation has reached a chronic stage. If movement and massage are neglected, painful adhesions form, which permanently impair movement; if movement is begun too early, pain is caused and the inflammation increased. In any particular case an injury may be not confined completely to the joint, and then a combination between treatment by rest and by movement has to be adopted. The knee and hip require a good deal of rest; the shoulder and elbow must be moved early.

Tubercular Arthritis.—Tubercular disease commences in a joint by the formation of tubercles beneath the articular cartilage, at the line of the epiphysis, or in the synovial membrane, which becomes much thickened owing to an œdematous 'pulpy' change in the synovial membrane, along with an inflammatory thickening in the subsynovial connective tissue. Caseation and ultimately suppuration follow, the articular cartilage is raised, perforated, and the whole of the synovial membrane is affected, whilst a carious, ulcerating process extends the tubercular disease into the ends of the bone. The affection of the synovial membrane includes all the pouches, and the bursæ communicating with the joint. After perforation, abscesses form in the connective tissue, which ultimately burst through the skin. Through the fistulæ thus formed other organisms get in and further extend the caries. Tubercular epiphysitis communicates with the joint at the ends of the epiphyseal line, or at a later stage by slowly spreading through the epiphysis. Tubercular arthritis heals by the invasion of tissue cells, which remove the degenerated cells, and themselves form firm fibrous tissue. If the caseous masses are not completely removed, but are merely surrounded, encysted, by the fibrous tissue, the tubercular process may at any time start afresh from these foci.

Tubercular arthritis is commonest in children, and the tendency becomes less and less as they grow older. The worst subjects are the children of tuberculous parents; the other predisposing causes are cold, damp, confined air of towns, and insufficient food. Recovery from tubercular arthritis is consequently favoured by increase in age, and especially by fresh air, which is neither cold nor damp, and by food including fat, such as bacon, supplemented by cod-liver-oil. The children of tuberculous parents present less resistance to the attack of the disease, and fresh air is neutralized by a damp subsoil, or by one which is waterlogged in winter. At first a child improves under the good food and care of a town hospital, but later the case comes to a standstill for the want of country air.

An increase of the circulation favours healing, supposing the patient's resistance to be sufficient, and hence the following methods have obtained some success, viz., counter-irritation to the skin, massage and movement, the injection of a few drops up to a drachm of a 10 per cent. solution of chloride of zinc, injection of an iodoform emulsion in glycerin, venous congestion for a short time daily by compressing the veins above the joint. But when the patient's resistance is low, any increase of the circulation favours the growth of the tubercle, hence a slight injury is so often the starting-point of active disease, and long-continued rest, cold lotions, and mercury ointment favour healing by diminishing the circulation. The injection of Koch's tuberculin causes a marked inflammation in an affected joint, but the tubercular process, instead of being checked, is increased in many cases. Therefore these measures are likely to do good when the patient's general health and resistance to the disease have improved or can simultaneously be bettered. Surgical measures are directed to the removal of the tubercular products. Other tubercular lesions, such as diseased glands, affect prejudicially the healing of a joint, and must be also removed.

Rheumatic Arthritis.—Rheumatic arthritis may commence in the course of an attack of acute rheumatic fever, and be chiefly marked by a serous effusion. The serous effusion may be incompletely absorbed, and the joint remain in a state of subacute or chronic inflammation. Or the patient, after one attack, suffers again from slight exposure to cold, damp, or overwork. With each recurrence there is a greater limitation of the joint's movement from adhesions in the tendon sheaths around, and ultimately between the joint surfaces.

Rheumatic arthritis may commence in a less definite way. The patients are spoken of as suffering from a 'rheumatic diathesis,' which gets more marked as they grow older. The arthritis is accompanied by less effusion and by greater tendency to adhesions and limitation of movement. Septic infection makes this tendency worse. Gonorrhœal rheumatism is the result of the continuous septic infection acting on a person of a rheumatic tendency. It is occasionally set up by the first attack of gonorrhœa. Usually it is a complication of gleet and the formation of a stricture of the urethra. Gonorrhœa is often overlooked because the man does not perceive any gleet, and feels no difficulty in passing water. Any urethral discharge is very small, and the urethral stricture is often spasmodic. Although much less common in women, it may be occasioned by chronic gonorrhœal inflammation in folds and pockets of the urethra, or in the cervix uteri. The occurrence of rheumatic arthritis in a young adult which has not followed upon an attack of acute rheumatism, or from one of the other specific fevers, must at once raise the suspicion of a gonorrhœal origin, and the rheumatic affection cannot be cured unless the source of the affection is first successfully attacked.

Subacute and chronic rheumatic arthritis may be originated occasionally by other specific fevers, and especially by scarlet fever. The scarlet fever may pass unnoticed except for some obscure throat affection.

Chronic Rheumatic Arthritis—Rheumatoid Arthritis—Arthritis Sicca et Deformans. — This affection may be looked upon as a form of senile degeneration, which occurs to a more or less extent in old people, and in its slighter forms hardly constitutes a disease. When commencing earlier, and going on to a more marked degree, there is much pain, limitation of movement, or ankylosis, and deformity of the ends of the bone. This degeneration is favoured by the rheumatic diathesis, also by hard work, exposure, damp, and cold, by alcoholism, by disturbance of nerve influence, by lead-poisoning, by gout, and also by slight injuries and strains.

The degeneration commences by a fibrillation of the hyalin matrix of the articular cartilage, whilst the cells multiply and then fall out, leaving a rough velvety surface, which wears away and exposes the bone. The bone is also partly worn away, partly a chronic ostitis is set up, causing a change to a dense compact ivory- or porcelain-like surface. At the margin where the synovial membrane joins the articular cartilage, ossifying cartilaginous masses arise, so that the combined wearing away of the articular ends and the formation of new bone, of osteophytes, give rise to the term 'lipping,' and when the process has advanced further, to the term 'arthritis deformans.'

The synovial membrane becomes rough, with fibrous processes like the surface of a carpet, some of which are villous, others of hard tissue or cartilage. Upon movement a sharp crackling sensation is felt, and even heard. There is generally but little fluid in the joint, hence the term 'arthritis sicca'; but there may be, nevertheless, a considerable effusion in some early cases.

Gouty Arthritis.—This process is similar to that above described, except for the deposition of urate of soda in the articular surfaces. In advanced cases masses of urate of soda (tophi) form about the joints of the fingers, and these may even cause ulceration of the skin and suppuration. In most cases the changes in a joint are partly due to gout, partly to rheumatism, complicated by the effects of alcohol or of lead-poisoning.

Neuropathic Joints — Ataxic, Tabetic, or Charcot's Joints—Joints in Syringo-myelia and other Paralytic Affections.—As the result of impairment or loss of nerve influence, there is a rapid change in joints and in the ends of the bones, similar to those which occur in rheumatoid arthritis. Hence has been formed the conjecture that a loss of nerve influence is at the bottom of all these affections. At any rate, marked changes follow upon degenerative disease of the spinal cord, especially locomotor ataxia. In a typical case of Charcot's disease there is an effusion into the joint, with rapid loosening of the ligaments, and a wearing away of the ends of the bone, so that the whole articular ends of the bones disappear. In nearly all cases there is some new formation at the sides, causing a lipping, and less commonly enough new bone is formed, to produce ankylosis and a condition similar to the arthritis deformans caused by rheumatism. The same statement applies to syringo-myelia, sometimes the chief change consists in a wearing away of the bone, sometimes in irregular new bone being formed, and fixation.

Syphilitic Arthritis.—In the course of secondary syphilis an acute or subacute effusion takes place into a joint. The condition disappears under mercurial treatment, and it is doubtful what changes occur. A worm-eaten, serpiginous erosion of the cartilage has been described. A gumma may invade a joint and cause degeneration of the synovial membrane. The diagnosis from sarcoma is difficult, especially as a course of iodide of potassium may fail in curing the disease. It is then treated on similar lines to a tubercular joint.

Sarcomatous Arthritis.—A periosteal sarcoma may invade a joint. A rare form is a sarcomatous affection of the synovial membrane, which is difficult to distinguish at first from the other commoner causes of thickening synovial membrane. An early exploration for diagnosis is required, in order that the disease may be cured by amputation.

General Treatment of Arthritis.

Acute Arthritis is characterized by redness, heat, tenderness, and pain, accompanied by swelling and fluctuation, owing to the exudation of fluid. It is treated by cold lotions, an ice-bag, and rest. If there is much fluid, some of it should be aspirated, both in order to relieve pain and favour absorption and also for the diagnosis of suppuration.

Subacute and Chronic Arthritis is characterized by heat and pain, also by a collection of fluid, a thickening of the synovial membrane, or grating movement according to the cause. The general treatment consists in rest, iodine and mercury liniments and ointments, and the internal administration of drugs. Gouty arthritis is relieved by fomentation with alkalies, belladonna and opium.

Chronic Hydrarthrosis.—When a joint remains persistently distended by fluid, it should be washed out through a cannula inserted by means of a trocar or through a small incision.

Loose Bodies in a Joint originate in fibrin from extravasated blood or from fibrinoplastic exudations; or when single, a loose body may have as its nucleus a piece of cartilage which has been detached from the articular surface. A loose body may be felt through the synovial membrane, or there is a rattling something like the sensation yielded by peas in a bag. A loose body getting between the joint surfaces may suddenly lock the joint. Loose bodies are removed through an incision, the joint being also thoroughly washed out.

Thickening of the Synovial Membrane.—Chronic and progressive thickening of the synovial membrane is usually tubercular in origin, but there are rarer cases which are rheumatic, ataxic, gummatous, or sarcomatous. The whole of the diseased synovial membrane is excised by using a knife and scissors, the operation being called arthrectomy.

II. Septic Arthritis—Suppuration in a Joint.

There are three chief causes: septic infection through a wound or by extension, pyæmic suppuration, and as a sequela of tubercle. The most dangerous of wounds are septic punctures, for the exudation does not escape freely, as in the case of a lacerated wound. Suppuration and abscesses in the soft parts show no great tendency to spread to a joint; the extension is generally from septic inflammation and necrosis of the adjacent bone. Pyæmic suppuration typically causes the insidious but rapid collection in a joint of a thin, oily pus, with no special signs of inflammation, and without any marked changes in the joint surfaces. In some cases, as after gonorrhœa, there is a septic inflammation, causing a marked thickening of the synovial membrane, and pus forms but slowly and in small amount.

But it is tubercular inflammation which has the greatest tendency to go on to suppuration, and a tubercular taint induces suppuration as a complication of simple arthritis.

A suppurating joint has to be incised at once, cleared of all pus, and drained.

Movement *versus* Ankylosis of a previously Diseased Joint.—After the subsidence of inflammation, the surgeon has to decide whether active movement should be restored to the joint, or whether ankylosis should be his aim. The former is to be desired in nearly all cases affecting the upper extremity, and only in the very worst is ankylosis allowed. In the lower limbs a soundly ankylosed joint is the more useful, unless complete and painless movement can be restored, and therefore only the slighter cases are likely to be fit for movement. If free active movement is to be retained, massage and passive movements must be commenced as early as possible, and must be pursued daily. Ankylosis is obtained by fixing the limb in a permanent bandage after the wound has healed, or beforehand if a window can be conveniently cut for the dressings. The first stage of ankylosis is by fibrous tissue, and if the fixed apparatus be left off too soon, the weight of the body or the pull of muscles may, within any time up to a year, force the joint into a bad position.

Fibrous Ankylosis in a Deformed Position.

Ankylosis, or fixation of a joint, may be external (due to contracted tendons or bands) or internal (in which the surfaces are united by fibrous tissue or bone). If the ankylosis be external, it can be relieved by the open division of tendons or bands; but in the majority of cases it is internal as well. In an early case of fibrous ankylosis, by steady extension the limb may be brought into position, or the same may be obtained at one sitting by forced movement. Forcible movement of a joint under an anæsthetic must be preceded by a most careful attempt to arrive at an accurate diagnosis.

Neuromimesis is the name given to a condition in which ankylosis is simulated by muscular contraction, met with in young adults, who after a slight accident are unable to move the joint, which is held firmly fixed by the active contraction of the muscles. The diagnosis of neuromimesis is made in the absence of signs of injury or disease. Then, with or without the aid of nitrous oxide gas, the joint is forcibly moved, the movement being continued after the patient awakes, in order to convince him that there is nothing really wrong with the joint.

The danger resulting from forcible movements of a previously diseased joint is recurrence of the disease, or, worse still, in cases of long standing, even a fatal result from fracture, rupture of vessels and nerves, or fat embolism. Bones long fixed at a joint and unacted upon by muscles become exceedingly atrophied, and therefore easily fracture. The fatty marrow with which they are filled gets into the circulation, causes rapid respiration without a rise of temperature, failure of the circulation ensues, and fat globules are found in the capillaries of the lungs and other organs, showing by their presence that the circulation has been obstructed. Secondary to ankylosis, the sheath of the vessels and the artery itself shorten from the prolonged relaxation, so that when, for instance, the knee is forcibly straightened, the popliteal artery may be ruptured and gangrene of the limb ensue.

Only in recent cases should force be used to restore the position of joints. For old cases, if anything is done, it should be by open methods, such as cutting between the joint surfaces, excision of the joint, open division of fascia and tendons.

Bony Ankylosis in a Deformed Position.

An attempt to overcome bony ankylosis by forcible movement inevitably causes fracture of the atrophied bones in the neighbourhood of the joint. Open operations are always necessary, and these vary according to the joint and the result desired. To obtain a straight and rigid knee, a wedge-shaped excision of the ends of the bones is required; if a movable elbow be required, the ends of the bones are removed freely; if a fixed one, then only so much as to obtain flexion to a right angle. The head of the humerus has to be freely removed to obtain a mobile shoulder. A deformed hip-joint may be remedied by making a false joint just below.

Excision of Joints.

Joints are incised, washed out with water, wiped out with antiseptics; the surface of the bones is scraped or gouged away; the synovial membrane is cut off with a knife or scissors. These measures, which should prevent the necessity of excising a joint or, worse still, of amputating a limb are generally termed partial excision or arthrectomy.

Excision of a joint includes the complete removal of the whole of the articular surfaces. But owing to the diminished usefulness of the limb, and the tendency to subsequent deformity, excision is only indicated in order to save the limb from amputation.

CHAPTER XIII.

AMPUTATIONS AND DISARTICULATIONS.

AMPUTATIONS and disarticulations are operations which have to be done in order to avoid a fatal issue. They are only contemplated when no other means is likely to be successful.

Primary Amputations are now in many cases avoided by the prompt treatment of the wound with antiseptics. So long as the limb has not been practically cut off by the accident, so long as the circulation is going on, however feebly, in the limb below, the surgeon delays, replaces fractures, clears away foreign bodies and blood-clot, and replaces skin by grafting.

Secondary Amputations for Disease are prevented by the early treatment of diseases of the bones and joints, and by the careful maintenance of the circulation of the limb.

Amputation has, however, to be done with the utmost promptitude to save life under the following circumstances:

(*a*) **Spreading Traumatic Gangrene.**—There is no relation between the extent of the injury and the process, nor has age or other predisposing causes much to do with it. It may arise after small scratches as well as after extensive lesions. It may also spread by infection from one case to another. It is due to inoculation of the organisms which cause phlegmonous œdema. After the injury there is first pain, then rapid swelling; the skin becomes dusky, and quickly black. It spreads so fast that within one to two days the gangrene extends from the hand or foot as far as the elbow or knee. Meanwhile the patient suffers from the septic products absorbed. Only prompt amputation through the shoulder-joint or through the upper part of the thigh can save life.

(*b*) **Acute Septic Periostitis, Epiphysitis, and Osteomyelitis.**—This occurs especially in boys before or about puberty. After some trivial injury a high fever sets in, with pain often not well localized, and at first without much evident swelling. But so quickly may infection extend, that, within two or three days, if the case be not diagnosed and an incision made, including boring into the bone, the patient will begin to fail; the tongue becomes brown, there is delirium, rapid breathing, and a quick pulse. Thus, when seen late, only an immediate amputation can give the patient a chance. If fever continues, the patient must be frequently inspected, in order that the first sign of a pyæmic abscess may be detected. The oily fluid collects insidiously without superficial signs of inflammation in a joint, in the subcutaneous tissue or in the pleura. If the patient survives so as to allow of the evacuation of a pyæmic abscess, the prognosis is much improved.

(*c*) **Periosteal Sarcoma.**—A swelling commences in a generally young patient on the shaft of a bone, often after a slight blow. If painless, it is not likely to be a gumma. Still, iodide of potassium and mercury may be tried for a week to ten days. If there is no improvement in that time, an exploratory incision must be made; suppuration from quiet necrosis will be thus excluded, and a piece of the new tissue can be cut away and be examined under the microscope. The sarcoma is easily diagnosed if consisting of a soft, brain-like mass; if it is of a fibrous character, there is more difficulty in distinguishing a sarcoma from a gumma, even under the microscope.

A periosteal sarcoma being diagnosed, the limb must be at once amputated, so as to remove the whole bone affected. Periosteal sarcoma soon infects the glands, and those in the axilla or groin should be removed on the slightest suspicion of enlargement. The prognosis, however, even after early removal, is very bad; secondary growths in internal organs appear nearly always within four to six months.

(*d*) **Injury to Large Vessels.**—Amputation is required when the main artery and vein of a limb have been both torn and the anastomotic circulation is insufficient. A typical instance of this is the rupture of the popliteal artery and vein from a fracture of the lower end of the femur. In other and more doubtful cases one may wait for gangrene and even for a line of demarcation to appear, unless the patient suffers from septicæmia.

Method of Amputation.

1. **The Control of the Main Artery.**—This is the necessary preliminary in every case. It may be done by the elastic band. After the limb has been cut off, the main vessels are tied on the face of the stump, and then the elastic band is gradually relaxed and the smaller spouting vessels caught and tied. When the band cannot be conveniently applied, the incision is commenced so as to lead directly down to the main artery and vein. These vessels are then tightly ligatured on their proximal side and clamped on the distal side, and the division made between the ligature and the clamp. This primary ligature of the vessels applies especially to disarticulation at the hip and shoulder.

2. **The Cutting of Sufficient Skin Flaps** (Figs. 53, 54).—The length of the two flaps together should be at least one and a half times, and in a muscular part twice, the diameter of the limb at the point where the bone is cut through. Practically in all cases the flap consists of skin, subcutaneous tissue, and the aponeurosis covering the muscles. No muscle is included in the flap except just at the base. The flaps may be lateral, equal or unequal in length, the advantage being that the drain may be placed at the posterior end of the line of suture in the most dependent position. Antero-posterior flaps—the posterior being a little or much shorter than the anterior—are easily cut; the discharge escapes at the sides by two points instead of one; the posterior flap, if too long, may by its weight drag on the sutures. The best point about antero-posterior flaps is that the scar lies behind the end of the bone. Coat-sleeve or racket-shaped incisions are suitable for the shoulder and hip, the longitudinal incision being used for the preliminary ligature of the vessels.

A long, narrow knife is taken, and the flaps marked out with the point; then the flap is raised by cutting with the heel of the knife whilst the flap is retracted. The advantage of a long knife is that there is not so great liability to perforation of the flap as with a short knife, nor are there so many notches.

3. **Circular Division of the Muscles, Vessels, and Bone.**—The flaps, after being raised, are well retracted, and with the long knife the whole of the muscles and vessels are divided by one circular sweep down to the bone. There are no notches, only one clean transverse division of the vessels. The muscles are retracted a little further, the periosteum divided circularly, and the bone sawn across. Jagged bits of bone are cut off with bone forceps. Instead of flaps, the older circular method may be used by cutting through the skin with the heel of a long knife; the cut may be made horizontally or obliquely.

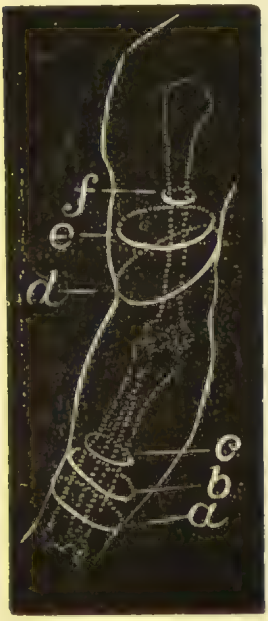

FIG. 53.—AMPUTATION BY CIRCULAR INCISIONS.

a, Through the skin; *b*, through the muscles; *c*, through the bone; *d*, oblique oval through the skin; *e*, circular division of the muscles; *f*, circular division of the bone.

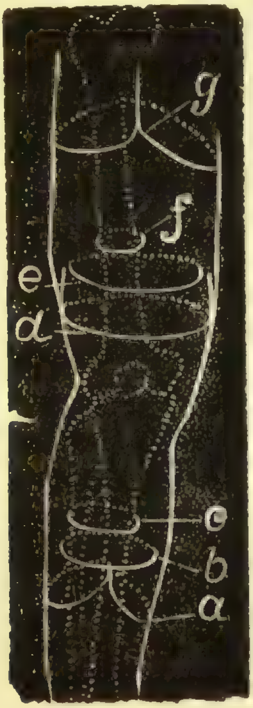

FIG. 54.—AMPUTATION BY MODIFIED CIRCULAR INCISIONS.

a, Lateral skin flaps; *b*, circular division of the muscles; *c*, division of the bones; *d*, antero-posterior skin flaps; *e*, circular division of the muscles; *f*, division of the bone; *g*, racket-shaped incision.

4. The large artery is carefully drawn from its sheath and ligatured, then the vein, then the smaller vessels, after gradually relaxing the elastic band. The stump being held up, the oozing soon becomes less, and hot water about 130° F. will tend also to contract the capillaries, whilst at the same time cleaning the wound. The large nerves are caught hold of and pulled out as far as possible, and cut off. This is very important in the upper extremity and whenever the skin flaps are rather short. For otherwise the nerve ends may become adherent in the scar, form bulbous, painful ends, and an ascending neuritis ensue.

5. The wound can be united by a continuous buttonhole suture, a few interrupted sutures being inserted if needed. Amputation flaps which only come together with difficulty are not likely to produce a successful result. A painful pointed stump, upon which the patient cannot bear weight, is probable. In such a case it is better to cut an inch or so more off the bone by retracting the muscles. A drain is inserted at the most dependent point, but it should not go more than sufficiently into the cavity of the stump to allow escape of the discharge.

6. After applying the bandage, a short splint may be added to check muscle twitchings. The bandage consists of longitudinal turns over the end of the stump, held in position by circular turns.

Complications of Amputation—Diseases of Stumps.

Suppuration, Sloughing.—Profuse suppuration is now prevented by antiseptic precautions. In cases of primary amputation for compound fracture, a desire to preserve as much of the limb as possible may involve the retention of bruised tissues, some of which afterwards slough. All pockets containing blood-clot surrounded by bruised tissues must be at the time of amputation slit up, wiped out, and dressed with gauze. If a portion of the flap becomes of a dusky-red colour and loses sensation, the sutures should be taken out, the flap raised as far as necessary, and iodoform gauze slipped underneath. Thus, the layer of gauze protects healthy tissue and the healing portion of the stump from being infected by the dying portion, whilst it in no way impairs the circulation in the flap so raised, but gives any portion which still retains its circulation the best prospect of recovering. As soon as the slough has become outlined by a line of demarcation from the rest, it is cut away with scissors.

Even partial suppuration is an important complication in a weakly or extremely exhausted patient.

A sinus, with a little bare bone at the end of the stump, is treated by enlarging the opening on the side opposite to the large vessels, scraping and gouging the end of the bone, and dressing with gauze, so as to start healing from the bottom.

Pointed Stumps.—Pointed stumps are due to the insufficient length of flaps cut at the amputation, to extensive suppuration and sloughing in the stump, to nerve lesions such as bulbous nerve ends, and in young people to the continued growth of the bone in the stump.

The bare end of the bone may actually protrude. The scar continues eczematous, or has a chronic ulcer ; it is so painful that it cannot be handled, or, at least, no apparatus can be worn. The nerve ends become bulbous, and an ascending neuritis extends to the nerve roots, or even to the spinal cord. The continuous eczema or ulceration of the stump renders the patient liable to epithelioma, or to keloid, or some other form of sarcoma.

It is a great mistake in amputation to be sparing of the flaps ; it is best to have their length fully two diameters of the limb at the point of section of the bone, rather than run any risk. Primary healing is a great preventative, but even then atrophy of muscles and retraction of skin from disease must be anticipated.

When a stump is pointed, the skin eczematous and ulcerating, the nerves painful and bulbous, no time should elapse before a longitudinal incision is made (avoiding the blood-vessels) down to the bone ; the bone is cut shorter, the bulbous ends of the nerves excised, and the proximal ends, if the seat of neuritis, well stretched or avulsed.

In children growth of bone must be expected and the flaps made long. Amputation through the knee-joint should be selected over one through the upper third of the leg. In the case of an amputation through the arm, in which the humerus continues to grow, it has been suggested that its growth should be arrested by destroying the upper epiphysis.

If there is a long piece of bone in a stump, and it undergoes eccentric atrophy, a fracture may occur, and the fragment may have to be excised.

Vascular Complications.—*Recurrent Hæmorrhage* has disappeared owing to the deliberation with which an amputation can be carried out under anæsthesia.

Secondary Hæmorrhage has become almost as rare owing to the use of antiseptics, especially antiseptic ligatures. A patient suffering from alcoholic delirium may endanger the stump by violent movements, but it can be protected by a projecting splint and abundant wool dressings. Secondary hæmorrhage is still met with if a ligature be applied to a calcareous, rigid artery. When an artery of this kind is found, a point higher up where the artery is less diseased must be sought for. Should secondary hæmorrhage occur, the artery must be ligatured in continuity above the stump, the stump opened up, cleared of discharges, firmly plugged with iodoform gauze in strips, and the whole covered with wool and firmly bandaged.

A pulsating stump, due to an aneurysmal varix, has occasionally happened; the artery and vein must be exposed above, and both ligatured in continuity.

Ischæmia and Gangrene of the Stump—not traumatic or septic—arises from previous obliteration of the smaller blood-vessels by thrombi, especially in the calf of the leg, and will be subsequently referred to. Under such circumstances, amputation through the thigh is to be preferred to any amputation through the leg.

CHAPTER XIV.

SURGERY OF THE HEAD.

The Scalp.

THE scalp consists of skin intimately united with the aponeurosis of the occipito-frontalis. A scalp wound, therefore, does not gape unless the aponeurosis also be freely divided. An apparently clean-cut wound may be done by a blunt object owing to the hard skull beneath. The vessels of the scalp are numerous, hence lacerated portions are still able to maintain their nutrition, and large flaps can be turned down in the course of operations. The walls of the blood-vessels are intimately connected with the fibrous tissue around, hence they do not retract when wounded, but bleed freely; the bleeding, however, is easily controlled by suturing and by pressure against the skull, which, owing to the vascularity, can be firmly applied. The main vessels before entering the scalp are in the loose subaponeurotic tissue, where they easily retract, and may be difficult to seize until the wound is enlarged. The hairy scalp collects dirt, which its sticky secretion aids in retaining, hence it becomes a favourable ground for the development of parasites. Cleanliness necessitates the removal of the hair and of the grease. The number of the sebaceous glands accounts for the frequency with which cysts are found. Blood or pus is strictly circumscribed when in the substance of the scalp, but beneath it spreads widely and floats up the scalp from the skull as far as the line of insertion of the scalp. The pericranium is attached along the lines of sutures of each bone, so that blood or pus beneath is limited to a single bone. The mobility of the scalp on the skull allows the skull to slip out of the way—*e.g.*, from beneath a wheel—and when a blow strikes the head obliquely—*e.g.*, a cricket-ball—the position of the scalp wound may not be opposite to the injury of the skull. The mobility of the scalp on the skull may allow of its being widely stripped up, *e.g.*, when a woman is caught by her hair in some moving machine. The tough fibrous tissue of the scalp does not allow of such stretching as does the ordinary skin, thus when the scalp is destroyed by a burn or by ulceration, any large gap must be replaced by grafting; every tag in the case of a lacerated wound should be saved, and fixed again in position.

Treatment of a Scalp Wound.—The hair is shaved off widely around, even in the case of small superficial ones. The scalp is washed with soap and water and turpentine until it becomes white, the wound is firmly sutured, and this stops most of the bleeding, except in the case of the main vessels, which require a ligature. A pocket formed by stripping off the scalp may be drained through a buttonhole made at its most dependent part.

For wounds of the vertex the roller bandage is carried under the chin and above the occipital protuberance. For a wound on the side of the head the bandage is applied horizontally, passing beneath the frontal eminences and the occipital protuberance, each turn crossing the preceding one like the letter **X.** When no pressure is required, a cap of lint or a triangular handkerchief serves to keep on the dressing.

Hæmatoma of the Scalp—Cephalhæmatoma.

A superficial hæmatoma in the scalp is always circumscribed, not extending beyond an inch or two in diameter; a hæmatoma beneath the aponeurosis is widespread; one beneath the pericranium is limited to the bone, generally the parietal bone, and occurs during birth. A hæmatoma feels soft in the middle from the fluid blood; at the margins is a hard rim, composed of inflammatory œdema, which requires to be firmly pressed with the finger before the skull can be perceived beneath. A hæmatoma is always superficial to the skull, and therefore the soft centre cannot be mistaken for a depressed fracture, which must necessarily be beneath the level of the surface of the skull.

A hæmatoma is generally absorbed. It may undergo septic infection, and suppurate. Then it is incised, and the clot turned out.

Acute Inflammation and Suppuration.

Erysipelas may begin in a scalp wound, or spread from the face. The scalp does not appear red like the face, but pale and œdematous, pitting on pressure. In a drunkard death from septicæmia is probable. Extensive suppuration, cellulitis, may follow, and spread widely, raising the scalp from the pericranium. Incisions are made at the most dependent points, *i.e.*, along the line of attachment of the scalp to the frontal ridges, the zygomas, and the occipital ridges. Simple erysipelas is treated by antisepticizing any wounds, protecting the scalp from the air, and administering quinine or perchloride of iron in full doses, also erysipelas antitoxin.

Chronic Inflammation is mainly parasitic in origin; not only is there exudation, but the sebaceous glands secrete more actively. The treatment consists in repeated washings after removal of the hair, and the use of antiseptic ointments, *e.g.*, ung. acidi carbol., grs. xii. ad ℥i. Abscesses form, but are situated in the scalp, and are circumscribed. They are scraped, and wiped out with pure carbolic acid.

Ulcers.

Syphilitic Ulcers are often multiple, and produce necrosis of the skull. They are treated with iodide of potassium, and mercury in small amount. Excess of mercury, as formerly employed, made matters worse. Any ulcer which does not readily heal should be scraped, the outer table of dead bone chiselled off, gauze applied until healthy granulations spring up, and then skin-grafting done.

Tubercular Ulcers are much rarer than syphilitic. They are multiple, and accompanied by caries of the skull. They are distinguished from syphilitic ulcers by the failure of anti-syphilitic remedies, and by the occurrence of tubercular ulcers elsewhere. The diagnosis can be proved by inoculation. The treatment is the same as for the syphilitic ulcers which do not heal with drugs. Ultimately death may ensue through septic thrombosis of cerebral veins.

Cysts or Wens.

The scalp has an abundance of sebaceous glands, and the secretion, when dried, forms dandriff. Obstruction cysts, from blocking of a duct, are, however, rare. The common sebaceous cyst of the scalp is a form of dermoid cyst.

They are first felt as little hard nodules, which extend, stretching the skin so that the hairs appear few and far between, and the skin thin and glistening, like that on a bald head. As the cysts increase beyond the size of a hen's egg or the fist, they tend to become pendulous. They generally occur in more than one member of the same family, and the liability is transmitted, especially to women. The wall of the cyst consists of stratified epithelium and corium, like the skin, with numerous sebaceous glands, but no hairs. The contents consist of a cheesy mass, composed of fatty acids having a characteristic odour. Hair, teeth, and other epidermal structures are not found in them. If left alone the walls may become ultimately calcareous, hence the term 'atheromatous' cysts. Or the cyst may burst, its inner lining extrude and form a foul, raised, ulcerating surface, which then simulates an epithelioma; or the secretion may become dried, and form a sebaceous horn. They are removed by incising and dragging out the cyst wall. An anæsthetic is unnecessary in simple cases. The cyst is rapidly transfixed by a long, straight bistoury, which then cuts its way out. The deep wall of the cyst is seized by forceps and dragged out, thus inverting it. It looks like the coat of a haricot bean. Thus the apex of the cyst, which is the most adherent, easily separates. It is a mistake to attempt a dissection; every bit of the cyst wall should come away. Small cavities are filled with gauze; large ones may be sutured and drained. Very small cysts may be punctured, and a crystal of nitrate of silver pushed in; the next day the cyst wall will easily come out through the puncture. When a cyst has burst, thorough erasion is required.

Dermoid Cyst above Outer Angle of Orbit.—A small cyst is often met with in children, which is attached to the periosteum, and which, if not removed early, may excavate a small hollow in the bone.

Malignant Disease of the Scalp.

A rodent ulcer, an epithelioma, or a sarcoma, may attack the scalp. A rodent ulcer generally extends to the scalp from the forehead and face, and is then already beyond the possibility of removal. It grows slowly for years, with a slightly indurated edge and a vascular floor, eating away the skull until it reaches the meninges and brain. During this time attacks of hæmorrhage may be caused by ulceration into small vessels. An epithelioma forms a more definitely-indurated ulcer, with everted edges and a foul base, and is followed by enlargement of the lymphatic glands. It must be distinguished from an everted suppurating sebaceous cyst; a sebaceous cyst, however, on which a horn has grown may develop epithelioma. It must be widely excised, and the place covered by a graft. Sarcomas of the scalp are commonly connected with the skull, so that excision may entail removal of part or the whole thickness of the skull. The distinction from gumma and syphilitic ulcers must be made early by administering antisyphilitic remedies.

Cirsoid Aneurysms of the Scalp.

Occasionally the temporal or occipital artery has upon it a congenital plexus of tortuous vessels, which increase into a pulsating tumour, by the dilatation of the vessels and the increase of fibrous tissue between and around them. Ultimately ulceration and hæmorrhage occur. The aneurysm is excised, the vessels supplying it being first clamped, and afterwards tied.

Neuralgia of the Scalp.

In order to cure neuralgia nerve-stretching is insufficient, as the pain soon returns; resection or avulsion must be done.

The supra-orbital nerve is exposed just above the supra-orbital notch, the auriculo-temporal just behind the temporal artery in front of the tragus, the great auricular in the groove between the external auditory meatus and the mastoid process, and the great occipital beside the occipital artery, midway between the occipital protuberance and the mastoid process. At least an inch should be resected, or the nerve pulled on until the proximal end is drawn out.

CHAPTER XV.

SURGERY OF THE HEAD (*continued*).

The Skull and the Brain.—Intracranial Pressure.

THE skull protects the brain, and, in regulating the blood-supply, does the work carried out in other parts by vaso-motor nerves.

The skull is, broadly speaking, a rigid covering which yields only when fractured. Yet, to a certain extent, it presents some elasticity, yielding on the application of force, and recoiling; this is especially the case in thin skulls. The skulls of children yield, but may not recoil, remaining depressed. The skull may yield before the force and undergo a linear fracture, which is no longer apparent after the recoil, although the brain may have been much injured at the moment of fracture. A linear fracture may be continued from the vertex, where the force was applied, towards the base. A starred or depressed fracture may, on the other hand, be strictly located in the vicinity of the injury. Extensive damage to the brain without corresponding damage to the skull may be due to the violence with which the brain is driven away from the point to which the force is applied against the opposite inner surface of the skull. Thus, from a blow on the back of the head the frontal lobe may be damaged by being driven against the inner surface of the frontal bone, the under surface of the temporal lobes lacerated by the petrous portion of the temporal bone from a blow on the vertex.

Both the scalp and the skull must be damaged before septic infection of the brain and its membranes can take place. The current in both veins and lymphatics is from within outwards; therefore, for septic infection to spread to the brain, the outward flow must first be arrested by thrombosis, and the clot undergo septic softening before extension takes place. Except after perforation of both scalp and skull, permitting of direct inoculation, septic infection of the brain and its membranes takes place through the arteries.

On opening the skull, the brain is seen to pulsate synchronously with the arteries and with expiration. Cerebro-spinal fluid flows out on dividing the dura mater, at first in a stream, then intermittently with the pulsations. If the surface of the pia mater be dried and watched, beads of fluid will soon reappear, showing the exudation of the fluid from the pial capillaries. The skull is, in fact, a cavity which is partly closed, but which communicates with the outside by many foramina: the foramen magnum affords a free communication with the spinal cord, lymphatics pass out of the smaller foramina. The brain is contained within the skull, but it does not completely fill the cavity, being surrounded and infiltrated throughout by cerebro-spinal fluid, *i.e.*, lymph. Every cell lies in a lymph space which communicates ultimately with that surrounding the brain. Arteries enter the skull and veins pass out; the lymph, as it filters out from the capillaries, is at a tension intermediate between the blood-pressure in the arteries and veins. This lymph, like all fluids, is practically incompressible, and can therefore regulate the blood-supply in the brain. If there is an increase of arterial blood-flow to the brain, and the blood-pressure in the cerebral arteries rises, more cerebro-spinal fluid filters out than can for the moment be absorbed, and therefore the intracranial tension rises and the brain expands. This increased tension compresses the small bloodvessels and diminishes the blood-flow; at the same time venous blood is driven out, so that the tension is soon lessened by an increased flow into the veins and lymphatics. Again, a slight obstruction to the venous outflow checks absorption of the lymph, the intracranial tension rises, and the brain expands, but, owing to the consequent diminution of the arterial blood-flow, secretion of lymph is diminished. It is thus seen that the cerebral circulation is maintained in a state of equilibrium, varied by the slightly increased blood-flow synchronous with the pulse, which adds blood and lymph to the brain, so causing it to expand, and by a diminished outflow of venous blood and of lymph during expiration, causing also an expansion of the brain.

Every brain cell lies in a cerebro-spinal lymph space surrounded by a capillary network, and any disturbance of equilibrium in the cerebral circulation tends to affect the cell, whether by cutting off its supply of oxygen or by preventing the escape of carbonic acid. The primary transient effect on the cell is irritative, and so excites overaction; the secondary and more enduring result is diminution of action, or paralysis.

The equilibrium of the cerebral circulation may be disturbed by changes in the inflow or in the outflow, or by alterations in the content of the skull. The arterial inflow may be at an increased pressure, which may go so far as to cause rupture of a bloodvessel when the wall has been previously diseased. A diminution of the inflow leads to fainting, especially when beforehand there is some general anæmia.

When a bloodvessel ruptures within the skull, the extravasated blood presses on the brain at every point at a pressure equal—according to hydrodynamical laws—to that of the blood in the ruptured artery. The brain cells affected are therefore no longer subjected to a pressure of 10 or 15 mm. Hg, a pressure less than the blood in the capillaries, but to a higher pressure according to the size of the ruptured artery. Therefore, so long as the ruptured vessel freely communicates with the extravasated blood, the brain cells compressed must be subjected to a pressure greater than that of the blood in the capillaries, and are therefore rendered anæmic. As soon as the ruptured artery is blocked by clot, the tension due to the blood pressure is taken off, and the compressed brain may re-expand and regain its function. If, however, the cranial cavity has been much diminished by extravasated blood, the clot remains under marked tension, the brain still compressed and the circulation of blood and lymph prevented.

An increase of intracranial pressure may be local, causing overaction or diminished action of a portion of the brain—*e.g.*, spasm or paralysis of the arm—or the whole cerebrum may be affected, as shown by an epileptic fit or by loss of consciousness. Following paralysis of the cerebrum, and loss of consciousness, the cerebrum and cerebellum are pressed backwards upon the floor of the fourth ventricle. Then the three vital centres governing respiration, the heart, and the blood-pressure are progressively excited, and with further pressure put out of action, as well as less important centres, such as the fifth and third root ganglia. Respiration is at first increased in rate and depth; then, along with the loss of consciousness, it becomes slow and laboured, then stertorous from the paralysis of the soft palate. Meanwhile the corneal reflex through the fifth nerve is lost. The respiration may finally have the Cheyne-Stokes rhythm, or pass through the stage of asphyxia and stop. Then also there occur the dilatation of the pupil and loss of the laryngeal reflex, indicating a paralysis of the third and vagus root ganglia. There is no reaction to light, and foreign substances passing into the larynx fail to excite cough. The spinal cord centres controlling the sphincters are likewise paralyzed. The heart rate is affected by severe pressure, the cardio-inhibitory centre is at first excited, and the heart-beats are slow and forcible. But if the pressure is continued, a gradual paralysis of the centre ensues; the rate of the heart is then rapid and its force weak.

The blood-pressure or pulse tension is at first raised, the centre for vaso-constriction being excited by the increased venosity of the blood; but with a continuance of the pressure the tension gradually falls, and the increased amount of carbonic acid in the blood is no longer able to excite the centre.

The Relation of the Prominences and Sutures of the Skull to the underlying Brain (see Fig. 55).

The simplest method of ascertaining the position of any portion of the brain is by means of the bony prominences and sutures of the skull. The longitudinal fissure and the longitudinal sinus lie beneath the line of the sagittal suture, between the root of the nose and the occipital protuberance, the longitudinal sinus extending laterally about 1 inch to the left, and ½ inch to the right, of the middle line. Half an inch behind the mid-point of the line drawn from the root of the nose to the occipital protuberance is the point for commencing the line marking the course of the Rolandic fissure. This line is drawn forwards and outwards at an angle of 67·5°, or three-quarters of a right angle, to the line of the

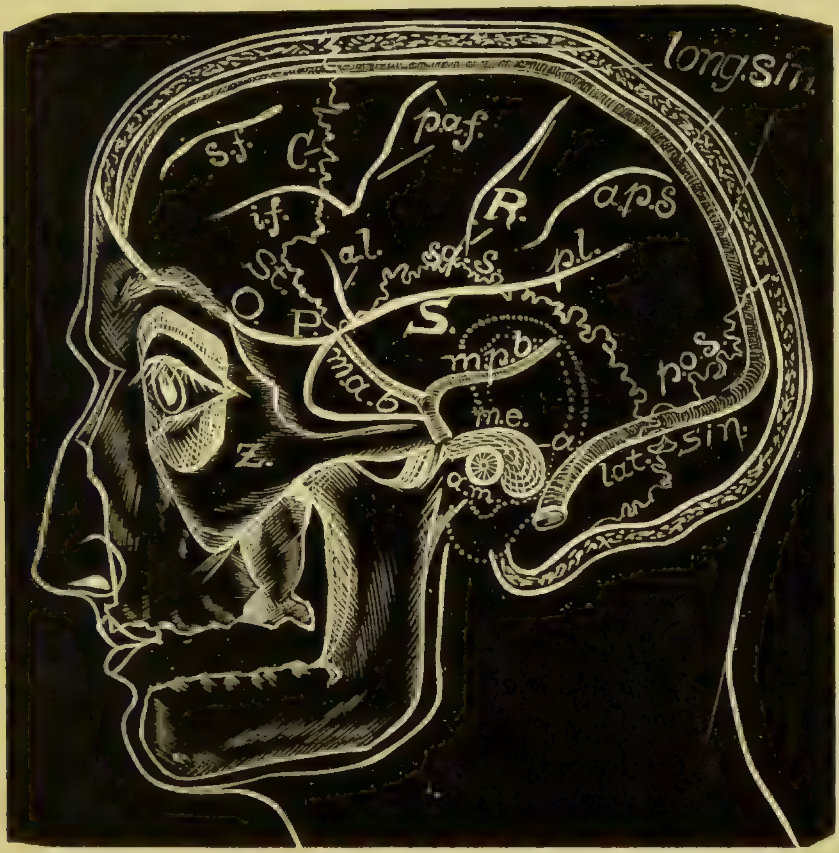

FIG. 55.—DIAGRAM OF THE RELATIONS OF THE SKULL TO THE UNDERLYING BRAIN AND BLOODVESSELS.

long. sin., Longitudinal sinus; *lat. sin.*, lateral sinus; *m a b*, meningeal artery, anterior branch; *m p b*, meningeal artery, posterior branch; *Z*, zygoma, *O*, external angular process of orbit; *C*, coronal suture; *sq. s*, parieto-squamosal suture; *St.*, stephanion; *P*, pterion; *p o s*, parieto-occipital suture; *R*, fissure of Rolando; *S*, fissure of Sylvius: *a l*, anterior limb, *p l*, posterior limb; *s f*, superior frontal sulcus; *i f*, inferior frontal sulcus; *p a f*, precentral or ascending frontal sulcus; *a p s*, ascending parietal or post-central sulcus; *a m*, auditory meatus; *m e*, middle ear; *a*, mastoid antrum.

sagittal suture. The outer and lower third of the fissure is a little more vertical. The breadth of a convolution separates the upper and lower end from the longitudinal and posterior Sylvian fissures. From the occipital protuberance to the base of the mastoid process runs the ridge which marks the great horizontal fissure and the hinder end of the cerebrum. The lateral sinus extends for about ½ inch below this ridge, and the sharp downward curve which it makes in passing to the jugular foramen lies behind the base of the mastoid process, and may extend as far forwards as the anterior border of this process.

The line connecting the frontal ridges and continued backwards to the centre of the external auditory meatus marks the base of the cerebrum in front and to the sides.

The line of the coronal suture can be felt at its junction with the sagittal, and at the point where it cuts the temporal ridge. The lower temporal ridge is indicated by the border of the muscle, when this is made to contract; the upper temporal ridge is just above where the sides of the skull suddenly become more vertical. The precentral or ascending frontal sulcus is just behind the coronal fissure; the inferior frontal sulcus starts from the precentral, and runs forwards at the level of the superior temporal ridge.

The fissure of Sylvius commences opposite the pterion. This lies about 1¼ inch behind the posterior edge of the external angular process and half-way down a line drawn vertically from the stephanion—*i.e.*, the point where the superior temporal ridge cuts the line of the coronal fissure, to the zygoma. The anterior limb of the fissure of Sylvius runs upwards for about 1 inch; the posterior limb runs backwards and upwards to end beneath the parietal eminence, and is the line of separation between the frontal and temporal lobes.

Operations on the Skull and Brain.

The scalp is shaved and repeatedly washed, markings of the positions of the brain may be made with an aniline pencil, and the scalp is wrapped up in a carbolic dressing about two hours beforehand.

About a quarter of an hour before the commencement,

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$\frac{1}{4}$ to $\frac{1}{3}$ of a grain of morphine is administered subcutaneously. Chloroform is employed, but less will be required if morphine precedes, and in any case only just sufficient is given to keep the patient quiet. During the operation the patient must be kept very warm by coverings and hot-water bottles.

Before the incision pins are driven into the skull to note the points for applying the trephine, and the projecting ends are cut short. Thus, when the scalp has been raised, the pins in the skull still mark the essential points of the lines drawn on the scalp. The incision cuts a flap which is horseshoe-shaped, or Ω-shaped if the arterial supply in the base be good. The scalp is raised with the periosteum only, or with the skull also attached.

The skull may be opened by a trephine 1, 2, or 3 cm. in diameter. The trephine should be conical and fluted on its outer rim, so that it shall neither slip into the skull nor move stiffly in the hole; the pin should protrude just enough to enter the outer table and fix the trephine whilst a groove is being cut, and is then withdrawn. The circular groove must be constantly examined by a fine probe, for the skull is nowhere of equal thickness, and the trephine will therefore cut through the inner table at one part of the circumference first. When this is found, pressure is made on the half yet to be cut through. When the vitreous table has been reached all round, the disc can be levered out by the elevator, even although the entire circumference of the vitreous table be not cut through. In order to enlarge the gap two or three trephine-holes may be made, and the bone between cut away by an angular gouge or by rongeur forceps.

In order to cut out bone quickly, an osteotome, a form of circular saw rapidly rotated by a dental engine, may be used. An Ω-shaped flap, with the skull still attached to the scalp, is raised by breaking through the piece of uncut bone at the base of the flap.

The dura mater is separated, so as not to be torn, by a flat-bladed seeker. The dura mater is opened by fine forceps and scissors, a flap being made with a sufficient margin projecting beyond the edge of the bone to admit of a suture later on.

The Brain is examined by inspection, by palpation, by gently retracting with a flat instrument, by electrical excitation, by puncture with a trocar and cannula, by incision.

Depressed bone may be raised, spiculæ withdrawn, blood-clot scooped and wiped away, and the puncture into an abscess cavity dilated by forceps. A cyst or tumour is scooped out after outlining the portion by vertical incisions, and remaining fragments are removed by gentle streams of water. Hæmorrhage is arrested by fine ligatures, by gentle sponge-pressure, or by stuffing lightly with iodoform gauze for a day. The hæmorrhage should be mainly from small arteries; the large arteries at the base of the brain are best avoided, for they are very difficult to tie. Hæmorrhage from the bone is stopped by antiseptic wax. The dura mater is exactly sutured unless when an abscess cavity has to drain. Pieces of bone, which have meanwhile been kept in warm saline solution, are replaced, and the flap sutured, with a small drain at the most dependent point, or this may be omitted. If plugs of gauze are inserted, the wound has to be united on the following day, the stitches being inserted at the operation.

The **Complications** following an operation are shock, a sudden fall of pulse tension, a feeble heart-beat, and shallow respiration. The chief precautions against this are the careful administration of the anæsthetic; the keeping the patient warm; the greatest care not to press upon the brain, through a yielding skull, when an increase of intracranial tension is already present; the arrest of hæmorrhage, especially avoiding injury to the vessels at the base; and lastly, the division of the operation into two parts when extensive removal of the brain for a tumour is necessary. The first operation consists in removing sufficient bone to thoroughly expose the tumour, and then carefully suturing the wound. The patient is allowed to recover for several days or a week from the first operation, and then the second is undertaken. This consists in reopening the wound, scooping out the tumour, and reuniting. The patient thus avoids the double source of shock from removal of the skull and brain at the same time. The scalp wound heals thoroughly well after the reopening.

Localization of Brain Tumours.

As a preliminary to a surgical operation on the brain, it is necessary to localize the disease if possible. This may be done by some surface lesion, such as a wound, the scar of a former injury, or by the pain felt by the patient or caused by pressure or by percussion on the skull. Further, there may be symptoms indicating disease of a particular part of the brain, as shown by a disturbance of the function of this part. Thus, if the disease involves the sensori-motor areas of the leg, arm, and face, there may be overaction, spasm of muscles of the opposite side; or diminished action, paralysis, with diminution of tactile sensation and of muscular sense. Affections of the frontal lobe may be indicated by deviations of the head and eyes, of the shoulder near the middle line, or by aphasia on the left side. Visual disturbances, hemianopsia, partial or complete blindness in one or both eyes, may point to pathological changes in the occipital lobes. Disturbances of hearing or deafness may be due to disease of the temporo-sphenoidal lobe. Unfortunately, where such information might be of service in pointing to an abscess, it cannot often be obtained, as the ear has been previously destroyed. Cerebellar disease may be localized by alterations in the gait, and in the action of ocular muscles, whilst the vital centres in the bulb begin to be impaired in advanced cases. For all lesions on the under surface of the brain, disturbance of the function of the intracranial portions of the cerebral nerves is of great service in the localization.

CHAPTER XVI.

SURGERY OF THE HEAD (*continued*).

Head Injuries.

SEVERE injuries are liable to be confounded with the effects of alcoholic or other poison, and with apoplexy, or all three conditions may be confused together. Thus, a drunken man may fall and injure his head, and whilst in this state an apoplexy may ensue, owing to the increased venosity of blood causing an elevation of pulse tension. Apparently trivial head injuries may be followed by a slow hæmorrhage, by recurrent hæmorrhage from disturbance of a clot blocking a torn vessel, by a sudden œdema of the brain, or by septic inflammation extending inwards.

An unconscious patient should have the stomach washed out if poisoning be suspected, be put to bed, 6 to 10 grains of calomel administered, and liquid food poured into the pharynx in small quantities, or nutrient enemata given.

The following errors in diagnosis must be avoided. A supposed drunken man should not be left on a couch or in a cell, but should be put to bed and treated like a sick person. Slapping, pinching, and applications of the electric current are useless, and, indeed, harmful. If a patient be in a condition to react to such stimuli, there is no need of them, and the pain then caused to the patient tends to bring the profession into disrepute. If the patient is comatose, such stimuli produce no apparent reaction, for sensation is abolished; but a strong electric current applied indiscriminately may easily spread to the vagus nerve and stop respiration by afferent excitation, or the heart by efferent impulses. Although the patient be comatose, bruises are easily caused by slaps and pinches, and may become the subject of legal investigations. Alcohol and ether injected under the skin are but slight stimuli, and, when absorbed, their only action is an anæsthetic one, adding therefore to the coma. Dilute ammonia or strychnine injections are the proper stimuli for failing respiration. The administration of strong coffee, hot applications, and rubbing, are suitable for the same purpose.

No injury, however slight its immediate effects, should be ignored. The patient should keep in bed until all pain has gone, take a purge, keep to a light diet, and absolutely avoid alcohol and exertion, both mental and bodily.

An injury to the head may declare itself by the signs of a scalp wound or fractured skull. The symptoms of an injury are:

1. *Pain.*—Pain alone, although there may be no other signs whatever, should be held to indicate some laceration, contusion, or hæmorrhage on the surface of the brain.

2. *Concussion* is asserted to be due to a shaking of nerve elements without necessarily any gross lesion; but it is better to assume that small yet widespread hæmorrhages are the cause. Concussion is evidenced by a loss of consciousness following immediately upon an injury. Partial recovery ensues after a shorter or longer interval, leaving a dazed condition, which gradually wears off. Pain may be felt, but the mind retains no memory of anything following on the injury.

3. *Compression* is the combination of symptoms indicating the paralysis of nerve elements described on p. 160. It may commence immediately on the injury or only come on slowly. A period of consciousness may separate the injury from the onset of the symptoms, a memory for events following on the injury then remains.

The remote effects of an injury are: an alteration and impairment of the intellectual faculties, epilepsy, or insanity. A local injury may cause Jacksonian epilepsy or local paralysis.

Fractures of the Vault.

If subcutaneous, only extensive depression or comminution can be detected.

If an open fracture, the injury may be detected by the finger or probe, or be visible.

A linear fracture must not be confounded with a suture. Symptoms are of the greatest importance as indicating the presence or absence of (*a*) extravasation of blood beneath the skull, (*b*) laceration of the brain, and (*c*) extension of the fracture to the base. If a period of consciousness has supervened between the injury and symptoms of compression, extravasation of blood is indicated. This is confirmed if the injury has been in the neighbourhood of the meningeal artery, and if an early feature of the compression has been the marked paralysis of the arm of the opposite side. In such a case, removal of the blood-clot and ligature of the middle meningeal artery is required.

Concussion immediately following on the injury, and not recovered from, whether compression be super-added or not, points to laceration and bruising of the brain, not likely to be remedied by operation.

A linear depressed fracture is accompanied by an external wound, and is produced by the stroke of a sabre or similar instrument, by which a long deep groove is made. If deep enough to have driven in the inner table, the depressed bone should be raised by chiselling along the sides of the groove.

Starred and depressed fractures are produced by violence applied to a limited area. A hammer may cause a starred fracture without much depression, but a sharp object like the corner of a brick will drive in the bone. On examination of the wound, comminuted fragments may be found driven into the brain, and must be drawn out. If an elevator can be got underneath a depressed fragment, it is levered up. It is only when the depressed bone is tightly wedged beneath the edge of the intact bone that the removal of more bone by means of the trephine is resorted to. The pin of the trephine is placed close at the edge of the intact skull, and only a small semicircle taken away, just enough to enable the elevator to be slipped under the depressed fragment. If the brain protrudes, it should be merely washed. No attempt at reduction should be made, for its protrusion shuts off the cerebro-spinal space from infection.

A punctured fracture may be due to a bullet, or to a pointed instrument like a knife, entering through the thin bone of the temporal fossa or orbit. No probing of the bullet-wound should be attempted, for it is impossible by a probe to distinguish the track of a bullet, the site of which is discovered by the X-rays. Trephining at the seat of puncture, and removing any blood-clot or foreign body lying on the surface should always be done. The roof of the orbit, together with a portion of the frontal bone, must be removed when the back of the orbit has been penetrated.

Rupture of the Middle Meningeal Artery.

The signs are those of compression, with opposite hemiplegia from pressure on the sensori-motor area, especially of the arm. If a period of consciousness supervenes, it tends to exclude the simultaneous laceration and contusion of the brain. The hæmorrhage may arise from either the anterior or posterior branch, and the best spot for the first trephine-hole, supposing no fracture to be found, is immediately above the middle of the zygoma. A curved incision is made from the external angular process downwards to the zygoma, and upwards again, to end just above the tip of the auricle. The flap is turned up and the superficial temporal vessels ligatured. The temporal muscle is now detached along the inferior temporal ridge, and separated from the bone downwards and forwards, so avoiding the wounding of the deep temporals. The artery is found about 1¼ inch behind the external angular process, but for the posterior branch the bone must be removed in a line towards the parietal eminence. If it be a depressed fracture, the wound is conveniently enlarged, the deep temporal arteries tied, the depressed bone raised, and blood-clot scooped or washed out. If the opening in the vessel is seen, a puncture is made on each side of the artery through the dura mater, both below and above the wound, and a ligature passed through the punctures behind the artery by means of an aneurysm needle. The vessel is thus tied above and below. If the vessel bleeds beneath the bone, this may be controlled by compression of the external carotid in the neck, and the bone chipped away until the artery can be secured. If the bleeding-point cannot be secured, a small plug is pushed down the groove towards the foramen spinosum, and if this does not control the hæmorrhage, a ligature may be put on the external (not the common) carotid.

Hæmorrhage from a Venous Sinus.

This may result from a fracture or occur during an operation. It is controlled by a small plug of antiseptic wool. Of course, if necessary, a sinus may be sufficiently exposed and ligatured on either side of the wound, the ligatures being passed as described for the middle meningeal artery.

Abscess following Injury.

Primary.—Since the introduction of antiseptic treatment this complication has become rare. If there is a septic wound, inflammation ensues, with œdema of the scalp, the escape of a thin, foul discharge, and fever. If the bone be intact, it may look white; whilst there is a zone of œdema around, which pits on steady pressure; and the patient may complain of a dull pain at the site of the wound, increased by pressure. The abscess is generally between the skull and the dura mater, and, if allowed to go on, may give rise to symptoms of compression.

The wound is explored, and sufficient bone removed to give a free exit to the pus.

Secondary.—A blow on the head often causes rapid extension of middle-ear disease, and thus becomes an exciting cause of a cerebral abscess.

Hernia Cerebri.

Hernia cerebri is a protrusion of granulation tissue through the skull, which shows respiratory and cardiac pulsations. It serves to shut off the rest of the cerebro-spinal space from infection.

Except for frequent washings and dressings, the hernia should remain untouched. It will generally disappear spontaneously when suppuration has stopped, returning within the skull with unexpected suddenness. Active treatment during the stage of suppuration will most likely set up fatal meningitis, or, at least, the hernia will return. If, however, the hernia does not disappear, astringents or antiseptics, such as pure alcohol, may be painted on, and gradually increasing pressure may be made upon the swelling, always provided that thereby no septic discharges are kept in.

It may become proper to excise the hernia and to unite the skin over it, but this operation can only succeed when everything is rendered aseptic, so that healing by first intention shall take place.

Fractures of the Base of the Skull.

Contact with broad surfaces produces fractures of the base; pointed objects cause local and depressed fractures of the vertex. The injury causing a fracture of the base of the skull may be indirect, due to an extension from the vertex. It is accompanied by bruising and laceration of the brain, and the extent of this complication is indicated by the severity of the symptoms of concussion. If symptoms of compression follow, either continuing hæmorrhage or cerebral œdema is signified, and a fatal issue is probable.

Fracture through the Anterior Cerebral Fossa.—Fracture through the anterior cerebral fossa is caused by blows on the forehead or between the eyes, or by a blow on the back of the head which throws the patient on to his face. The signs of the fracture are bleeding from the nose, followed by a serous discharge and attended by loss of smell. The blood may be swallowed and afterwards vomited, or darken the stools. Extravasation of blood takes place into both orbits, causing proptosis, and beneath the palpebral conjunctiva. A black eye is distinguished from fracture of the base by the bruising being generally most marked on one side, affecting chiefly the eyelids and the ocular conjunctiva, whilst the palpebral conjunctiva may escape. Simple epistaxis due to a blow is of temporary duration, and is not followed by a serous discharge.

Fracture through the Middle Cerebral Fossa.—Fracture through the middle fossa is caused by a blow on the ear, or by extension from the vertex to the base. The special signs are bleeding from the ear, followed by a blood-stained serous discharge. Facial paralysis is noted, and if the patient recovers consciousness, the hearing is found impaired.

Fracture through the Posterior Fossa.—Fracture through the posterior fossa is caused by a blow on the occiput, or by falls on the feet or buttocks conducted upwards through the vertebræ to the occipital condyles. Instantaneous death generally results from injury to the bulb. Cases have survived, and there have then been signs of fluid beneath the muscles attached to the occipital bone.

Serous fluid flowing from the ear or nose is shown to be cerebro-spinal fluid, by containing a substance, pyrocatechin, which gives Trommer's test for sugar, but which does not undergo the alcoholic fermentation with yeast.

The general treatment of fracture of the base is prolonged rest until all pain and dizziness has passed off, a low diet, and aperients, commencing with a full dose of calomel.

The local treatment consists in washing and wiping away blood, insufflating iodoform or boric acid powders, the application of antiseptic dressings over the ear, and the plugging of the nose with strips of antiseptic gauze.

CHAPTER XVII.

SURGERY OF THE HEAD (*continued*).

Tumours of the Skull and Brain.

CEPHALALGIA, pain in the head, persisting for some time, whether following an injury or no, may be superficial or deep-seated. Superficial pain may be due to a nerve caught in a scar of the scalp or between the edges of a fracture. It may arise from a Pacchionian body, a small exostosis, or spicula of bone irritating the dura mater. The persistence of the pain at one spot will indicate the necessity for exploration, and the removal when found. Severe pain or cephalalgia may attend the growth of a tumour or the formation of an abscess. The pain may be widespread, a frontal or occipital headache being complained of, rendering sleep impossible. A particularly painful spot may be found on deep pressure, or on percussion, or on the application of heat or cold.

Exostosis.—The tumour may simply grow from the outer surface of the skull, or may at the same time extend inwards and press on the brain. They are of ivory-like hardness and sessile; hence, a skull has been fractured in the attempt to chisel them off. They are cut off by a fine circular saw, or the base bored through by drills, or part of the whole thickness of the skull removed by trephining.

Pulsating Tumours.—Tumours having only a cardiac pulsation, and not reducible, are malignant tumours or gummata growing from the skull. Those which have both a cardiac pulsation and a respiratory impulse on coughing belong to the brain. They may be meningoceles, encephaloceles, hydatid cysts, gummata, or malignant tumours which have perforated the skull.

Malignant Tumours of the Skull.—If single and circumscribed, the tumour is a sarcoma, and removal may be attempted along with the bone beneath. The tumour grows from the pericranium, diploe, or dura mater, and later perforates the skull, both outwards and inwards.

Multiple tumours may be sarcomata or carcinomata, and are secondary to some new growth. They are not amenable to surgical measures. In any case gummata must be excluded by preliminary treatment.

Meningoceles and Encephaloceles.

They are congenital or due to an injury, either a subcutaneous fracture with absorption of bone or an open fracture.

They must be presumed to be encephaloceles—*i.e.*, to contain a portion of brain, and a prolongation from the horn of the lateral ventricle, or from the third or fourth ventricle. The brain may be so thinned out as to resemble a meningocele, hence the term 'hydrencephalocele' or 'cephalhydrocele.'

In the congenital variety, the infant is watched for a time to see if the protrusion will get less with gentle pressure, and, further, to observe whether the child will develop hydrocephalus. If it become satisfactorily strong at a year old, excision may be done, the base being exposed and ligatured before the projecting portion is cut off.

When ruptured at birth, the pedicle of the tumour must at once be ligatured after turning back the skin, so as to shut off the brain cavity. The tumour is then cut away.

Gaps in the Skull.

Subcutaneous injuries to the skull in childhood set up an inflammatory absorption of bone, producing a gap like the anterior fontanelle, *e.g.*, in the parietal bone. A gap may be left after an accident, or after an operation, or as the result of necrosis.

A flap, consisting of scalp, pericranium, and the outer table of the skull, is raised by a chisel and laid over the gap as follows (see Fig. 56): The flap of skin *a*, *c*, *b* is raised from over the gap *g*, but remains attached about the angle *b*: the flap *c*, *b*, *d* is raised by the chisel from the neighbouring skull, but still remains attached about the angle *c*. The flap *c*, *b*, *d* is now turned on the pivot *c* to cover *g*, and the flap *a*, *c*, *b* being turned on the pivot *b* is stitched in its place.

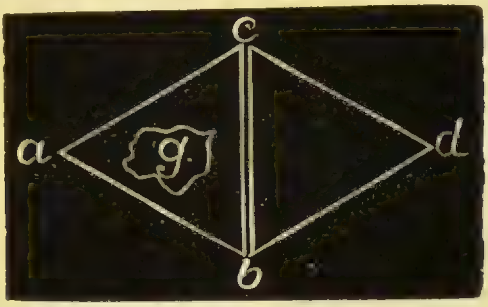


FIG. 56.—CLOSURE OF GAP IN SKULL.

Cerebral Tumours.

The three cardinal symptoms of a cerebral tumour are vomiting, optic neuritis, and cephalalgia, which gradually increase in severity. An abscess may present the same symptoms, but in a less marked degree.

The simplest conditions for diagnosis are: (*a*) A tumour following on an injury (beneath the scar may be found a cyst, a fibro-cystic tumour, or a malignant tumour); (*b*) an abscess following an injury (the abscess may lie on the surface, or a layer of apparently healthy brain may intervene); (*c*) an abscess following ear disease (the abscess may be confined to the meninges or involve the brain).

In the case of other tumours, the exclusion of a syphilitic gumma has to be made. Negative evidence as to syphilis is of little value, and inherited syphilis is more difficult to exclude than the acquired. Practically, in nearly all cases of a cerebral tumour not of the simple forms above mentioned, it is necessary to subject the patient to a full course of iodide of potassium and mercury. But this treatment must not be pursued too long. Some temporary relief from diminution of congestion may at first appear, but unless there is a definite and decided improvement in a month, the treatment should be discontinued. At any rate, from six weeks to three months are the extreme limits for its duration. Positive evidences of past syphilis by no means exclude the presence of malignant disease. A gumma may be only partly cured.

Other signs of tubercle may increase the probability of the tumour being a caseous mass, and if it prove single and limited, the prognosis is good.

Sudden increase of the signs indicates œdema or hæmorrhages in a rapidly growing, probably malignant, tumour.

A steady increase, involving further portions of the brain step by step, points to a diffused growth.

An encapsuled or well-defined tumour, gliosarcoma, fibrosarcoma, gummatous, tuberculous, or hydatid tumour is removed. An infiltrating, ill-defined, vascular tumour is a malignant sarcoma which should be let alone, especially when involving large arteries near the base of the brain.

Removal of Bone for Relief.—The fact of removing bone widely over a tumour may greatly relieve pain; may arrest the optic neuritis, which would otherwise soon cause blindness; may lessen the number of fits, vomiting, or other symptoms of pressure. Therefore, this operation may be undertaken where no idea of removing the tumour is entertained. The rest of the life of the patient is rendered thereby much easier.

Microcephaly.—Bone has been removed, generally a strip on one or both sides of the sagittal suture, on the supposition that the skull confined the brain. This is erroneous: the skull is small, not because of premature ossification, but on account of the ill-developed brain. The children bear operations badly, and there is no prospect of improving their minds by this means.

Epilepsy.—If there is a clear history of injury from which the epilepsy began; if the fits begin always in the same way, in the limb corresponding to the area injured; especially if they are preceded by a sensory aura, such as pain or abnormal sensations; more definitely still, if the fits are limited and do not extend to the rest of the body, nor are attended by loss of consciousness; if between the fits there are signs of weakness, paresis, or rhythmic movements —all symptoms indicating a strictly localized origin of the epilepsy, then the area involved may be excised. If the Jacksonian epilepsy be not absolutely cured, the fits are generally diminished in number and severity. There is always the chance of finding an unsuspected tumour, which may be removed, and so bring about the cure of the patient. No improvement will follow an operation unless the epileptogenous zone is a strictly limited one.

General Paralysis.—In certain cases of general paralysis the marked feature is an increase of intracranial tension. Then trephining, so as to relieve tension by letting out cerebro-spinal fluid, is indicated.

Intracranial Aneurysm.

The intracranial aneurysms which are of interest to the surgeon are confined to the region of the cavernous sinus, and are either an aneurysmal varix or a varicose aneurysm. A leakage of a small amount of blood takes place from an artery into a vein or into the sinus. Sometimes the aneurysm dates from an injury to the head or a strain. Subjective noises are the first sign, and there follows protrusion, proptosis, of the eyeball. A bruit may be heard on auscultation, and a pulsation of the eyeball felt, both of which are affected by pressure on the carotid.

The patient is at first kept at rest in bed, and given iodide of potassium. If the symptoms continue, and especially when compression of the carotid artery checks the pulsation and bruit, the common carotid artery is ligatured. Cure has been delayed until after ligature of the other carotid, showing that the aneurysm communicated with the artery of both sides.

Hydrocephalus.

Aspiration of the distended ventricles through the skull has not been successful. If the fluid is drawn off too quickly, convulsions ensue, followed by increasing weakness and death. Even if there is temporary relief the fluid soon recollects.

Incision and drainage, successful in a few, have failed in the majority. The flow has been too rapid or too slow, and the tube has blocked, or septic infection has spread inwards.

The most promising operation consists in trephining the occiput below the protuberance; a probe, followed by dressing forceps, is passed into the fourth ventricle, and a drain made of a number of strands of horsehair inserted. Through this fluid escapes slowly but continuously, owing to the wound being in a dependent position. Drainage of a lateral ventricle is not likely to succeed unless the fluid is encysted, for the opening is not dependent.

Hydatid Cyst of the Brain.

Hydatid cysts of the brain have occurred in about 4 per cent. of all cases, or in one to every twelve cases of liver cysts. The majority have been acephalocysts, recognised only by the cyst wall, like boiled macaroni with a peculiar laminated structure. Echinococcus heads and hooklets are then absent, there is scarcely any adventitious capsule, and the fluid closely resembles cerebro-spinal fluid. The coexistence of a cyst in the liver or elsewhere may aid in the diagnosis.

Small cysts have exhibited the signs of a localized cerebral tumour, and have been removed from the cortex of the cerebrum and from the cerebellum. Others have commenced in the substance of a hemisphere, and have yielded slight indefinite symptoms such as headache, staggering, loss of vision. The sutures of the skull have separated in children; in adults the skull has been perforated by pressure atrophy.

When exposed the cyst is removed by floating it out on a stream of water.

CHAPTER XVIII.

SURGERY OF THE HEAD (*continued*).

The External Ear or Auricle.

Wounds may be incised or lacerated, or the ear may be torn away from its attachment to the bone. In any case it is exactly sutured, and will heal, however small the attachment remaining, for the circulation is good.

Contusions, when repeated, as in boxing or at football, produce not only a hæmatoma, but chronic inflammation in addition, and thickening. This leads to distortion of the cartilage of the ear and to puckered scars, or a cyst may form, requiring incision and plugging. Hæmatoma auris is especially frequent in lunatics, taking place in them from comparatively slight injuries.

Outstanding Ears are due to a congenital lack of rigidity in the cartilage; in the worst cases the ears may have drooping tips, like those of a dog. They are cured by a plastic operation. An incision is made behind in the fold between the auricle and the scalp, and then a semilunar incision to include much or nearly all the skin on the back of the upper part of the auricle. The skin thus marked out is excised. A suture then draws the auricle close back to the side of the head, and the scar is left out of sight.

Inflammation of the Auricle.—Inflammation frequently spreads to the auricle from the meatus owing to the irritation of a purulent discharge. As a consequence of perforation of the lobule for the insertion of earrings, an abscess or erysipelas may arise, or the inflammation may cause a chronic thickening, leading to a pendulous lobule, which has to be excised.

Sebaceous Cysts frequently occur. They are obstruction cysts, the duct being marked by a black spot, as distinguished from those on the scalp.

Rodent Ulcer and Epithelioma are met with in the aged, and are often preceded by eczema. Syphilitic ulceration must be excluded.

The External Auditory Meatus.

Wax and Epidermal Concretions are very frequently the unexpected cause of deafness, pain, and irritation. The masses are washed away by repeated syringing with warm water after being softened by dropping in olive-oil.

Foreign Bodies of different kinds gain access. Seeds of plants are pushed in by children, and, if dry, they quickly swell up and become impacted. Insects occasionally get in, and by buzzing against the tympanum make a deafening noise. Harm may ensue by the collection of discharges behind the foreign body setting up middle-ear inflammation, but more especially rough attempts at removal of wax or foreign bodies may lead to perforaticn of the membrana tympani. It must be remembered that in children the bony meatus is not yet developed, and the membrane is consequently almost level with the outer table of the skull.

Repeated syringing is the proper method for removing a foreign body. Oil may be dropped in to soften an object or to kill an insect. When the meatus is thoroughly illuminated, the object may be seized with fine forceps, or caught in a snare, or hooked out by a probe. But it is better to let the body alone rather than to rupture the membrane by pushing against it.

Furuncle or Boil is very painful, and tends to block the meatus. Pain may be eased by a pledget of wool soaked in equal parts of opium tincture and warm glycerin. An incision as early as possible is the only satisfactory treatment. Hot fomentations, with or without half a teaspoonful of opium tincture, will soon give relief after the incision.

Earache.

This is a symptom of some condition which has to be discovered if possible. Its cause may be found in the external or middle ear, in the nose (nasal obstruction), in the pharynx (tonsils and adenoids), in the mouth (carious teeth), or in some general cause, such as anæmia.

Pending the discovery of the cause, earache may be relieved by dropping in hot water, almond-oil, opium tincture, 10 to 20 per cent. of the glycerin of carbolic acid, or a 5 per cent. solution of cocain. Extract of belladonna and glycerin may be painted round the ear, and hot fomentations applied. Ether vapour will also relieve.

Exostosis.

Exostosis is said to occur with special frequency among sea-water bathers, and is then bilateral. It may occasion no trouble, and is then left alone. If deafness and retention of discharges arise, removal is indicated.

The removal is done through an incision in the fold behind the ear; the auricle is then hooked forwards, and the exostosis cut off with a chisel. When pedunculated and of cancellous tissue, it is often removed by boring the base through with a dental drill, but there is more likelihood of injuring the membrane, and the base may not be removed sufficiently to prevent recurrence.

Polypus.

An aural polypus is a button of granulations, due to suppuration and carious bone, either in the external meatus or growing from the middle ear through a perforation in the membrana tympani. When small, after thorough syringing, the polypus is touched with chromic acid or with a cautery point, or caught in a fine snare or forceps. When large, with much pus, especially if there are signs of retention, erasion of the middle ear is done with a small curette.

Malformation of the Auricle and Middle Ear is connected with an irregular development of the hyomandibular arches and cleft.

The Membrana Tympani.

The membrana tympani may be wounded by a foreign body driven down the meatus. It may be ruptured by a blow on the head or side of the ear, or by a violent explosion. Hearing will be impaired, but sound will be conducted through the bones, unless the internal ear and auditory nerve ends are likewise damaged.

Perforation is due to suppuration in the middle ear; it readily occurs in children at an early stage. In adults there may be acute retention of pus, requiring incision; this is made by a narrow knife downwards and outwards from the centre. The membrane heals much more readily after an incision than after a spontaneous perforation. A perfect recovery may follow in the former case, whereas some diminution of hearing may be expected after spontaneous perforation in adults, although there may be good recovery in children.

A plug of cotton-wool lightly inserted and frequently changed protects from sudden changes of temperature, breaks the violence of sounds, and is the best form of artificial drum, for the patient learns to adjust it so as to produce the most effect.

Suppuration in the Middle Ear

may be primary following catarrh in weakly and tuberculous subjects, but it is usually secondary to nose and throat affections of all kinds. Scarlet fever, measles, diphtheria, small-pox, hypertrophic rhinitis and pharyngitis forming adenoids, enlarged tonsils, atrophic rhinitis with crusts, nasal polypi, syphilitic necrosis, etc., are all causes owing to extension by the Eustachian tube. At first the inflammation may be simple, and the discharge escape into the pharynx, but on the tube becoming blocked there is retention, followed by suppuration and perforation of the membrane.

The local treatment consists in syringing through the external meatus with insufflation of iodoform or boric acid powder, inflating through the Eustachian tube by politzerisation, or by passing a Eustachian catheter, so as to irrigate the middle ear through it.

Politzerisation is done by inserting the nozzle of a Politzer's bag into one nostril whilst the other is closed, and then suddenly compressing the bag at the moment that the patient swallows.

A Eustachian catheter is passed through the anterior nares until its nozzle reaches the junction of the hard and soft palate; it is then turned outwards and slightly manipulated until it enters the Eustachian orifice. When the throat is sound, the patient may inflate the middle ear himself by expiring with the throat and nose closed.

Suppuration extends from the middle ear to the mastoid antrum, whence necrosis may spread to the temporal bone, or form an abscess under the periosteum behind the auricle, or spread to the post-auricular and other lymphatic glands in the neck, or collect in an enlarged cavity as an inspissated caseous foul mass, called a cholesteatoma.

Exposure of the Antrum.

The antrum is exposed by a curved vertical incision, with the convexity backwards, made behind the ear after drawing the auricle forwards. At the upper and posterior border of the external auditory meatus, the bone is removed either by a gouge or trephine. When simply opening the antrum, it is undesirable to expose the lateral sinus, which comes as far forwards as the anterior border of the mastoid process, and the middle cerebral fossa is avoided by not removing bone above the level of the upper border of the meatus. The bone to be cut through in order to open the antrum varies from a layer as thin as paper up to $\frac{3}{4}$ inch of densely sclerosed bone. The former condition is met with in children, and in recent acute cases, the latter in adults in whom the disease has had a long duration. No harm is done by removing the posterior wall of the external auditory meatus.

The antrum and middle ear must be cleared of all granulation tissue, and the operation only ends when water will pass freely through the meatus and out from the wound, and *vice versa*. The wound is completely sewn up; the meatus serves for irrigation and drainage, and a persistent sinus is thus avoided. Enlarged glands are scraped or excised. Necrosis of the temporal bone may lead, by extension through the tympanic plate, to a collection of pus between the bone and dura mater, or in the groove of the lateral sinus, or may cause paralysis and degeneration of the facial nerve in the Fallopian canal.

An exploratory operation having shown that no collection of pus exists in the middle ear or antrum sufficient to account for the symptoms, bone is removed by means of a trephine, or chisel, or angular gouge, until the middle cerebral fossa is explored outside the dura mater; or the groove of the lateral sinus is exposed by removing bone at the base of the mastoid process. If the lateral sinus be wounded, and bleeds freely, it is clear that no clot has formed. It is easily controlled by a small plug of antiseptic gauze, which may be smeared with antiseptic wax.

Sinus Pyæmia.

In addition to the signs of old ear disease, the patient has rigors, with sudden elevation of temperature, followed by as sudden a fall and sweating. Pain in the neck along the internal jugular may be complained of, or a hard cord develops, indicating the thrombosis of the vein, as an extension from the lateral sinus. This thrombus may rapidly break down, the suppuration spread outside the vein, and form a large abscess in the neck full of most foul pus, surrounded by tissues in process of sloughing.

The pulmonary symptoms are, first, rapid breathing, then some rales are heard, the breath becomes foul, some consolidation of the lung appears, along with flushed cheeks and a dry and shrivelled tongue. These conditions, unless arrested, may quickly lead to multiple abscesses and gangrene of the lung. Instead of attacking the lungs, a pyæmic exudation of an oily fluid may quietly appear in one or more joints.

Treatment.—The operative measures are in three stages:

(*a*) The exposure of the lateral sinus groove in the base of the mastoid process.

(*b*) The incision and removal of decomposing clot from the sinus.

(*c*) The ligature of the internal jugular vein in the neck; the lower end is tied if possible below the thrombus, the upper end is brought out of the wound incised, and the clot removed. Water may then pass through the vein and out by the lateral sinus. An extension of the pyæmia may thus be prevented. Unfortunately, septic processes may have already appeared in the lung or in the joints. Even after ligature of the internal jugular pyæmic infection may spread by anastomosing channels.

The patient must be frequently and thoroughly inspected, and the first appearance of fluid in a joint is the sign for an immediate evacuation. Should the patient have reached this stage without marked lung complications, a more hopeful prognosis may be given. Every œdematous or fluctuating swelling in such a case should be incised as soon as seen.

Abscess of the Brain.

Abscess of the brain, arising from ear disease, may form in the temporo-sphenoidal lobe or in the lateral lobe of the cerebellum. For a variable time the abscess remains localized. When it bursts, death may be sudden, or the fatal termination may be immediately preceded by purulent meningitis.

The diagnosis is made by first excluding other ear complications; the antrum is cleared out, the groove of the lateral sinus examined, and the temporo-sphenoidal fossa outside the dura mater explored.

The general condition to be excluded is, in the first place, typhoid fever; empyema or abscess in the lung is less likely to be confused with cerebral abscess. The general signs of cerebral abscess are a gradual impairment of consciousness, a fever of the typhoid or asthenic type, with signs of increasing intracranial tension similar to those of compression. A subnormal temperature, especially when it follows on a period of raised temperature, and is accompanied by a worsening of the patient, points to a brain abscess. The pulse generally becomes slow—50 to 60 per minute in the earlier stages, rapidly increasing towards the end. The localizing signs are not very trustworthy. If optic neuritis is present, it may be more marked in the eye of the affected side. Pain, whether spontaneously complained of or brought out by pressure, percussion, or the application of warmth or cold, may indicate meningitis over the surface of the abscess. Special paralytic symptoms have been sufficient to enable a diagnosis to be made of a temporo-sphenoidal or cerebellar abscess. But, as a matter of fact, all special signs of a cerebral abscess are frequently absent. The patient gets more and more stupid, his tongue browner, his temperature sinks, his pulse gets slower, and he quickly dies unless relieved by an exploratory operation.

Operation for Cerebral Abscess.—After excluding extradural sources of suppuration, a small opening is made in the dura mater. Brain under tension bulges, shows no pulsation, and the convolutions are flattened. The brain should then be punctured in different directions with a hydrocele trocar and cannula. Pus may flow, or foul gas escape, or an odour cling to the trocar. If it and the cannula be washed, pus cells may be found in the washings. The brain may be simply softened, and have not yet broken down into pus. When the abscess is found, the track is dilated by sinus forceps, and the cavity gently washed out; a drain is unnecessary. The external wound is only partly closed, the rest being filled with gauze, which is frequently changed.

When there are the signs of cerebral abscess, yet no distinct evidences as to position, it is generally best to explore the temporo-sphenoidal lobe first. The middle temporo-sphenoidal fossa is exposed through an opening immediately above the level of the upper border of the external auditory meatus and just behind. The bone can be removed by a trephine or an extension from the antrum made by means of rongeur forceps.

The lateral lobe of the cerebellum is explored either because there are signs of paralysis attributable to a tumour of the part, or because the previous exploration of the temporo-sphenoidal lobe has proved negative. It is exposed just behind the mastoid process and below the curved line. The bone is here very thin—indeed, often so thin as to be diaphanous. When the cerebellum is exposed, the following steps are similar to those described for the cerebrum.

CHAPTER XIX.

SURGERY OF THE NOSE AND UPPER JAW.

Nasal Meningocele, Dermoid Cyst, or Nævus over the Nasion.

THESE conditions may occur together or separately, situated over the nasion at the junction of the nasal and frontal bones. The most important is the meningocele, the hollow pedicle of which must be carefully ligatured during the excision, otherwise an open channel is left by which septic inflammation may reach the meninges.

Boils and Sebaceous Cysts on the Nose.

Boils and sebaceous cysts are very painful owing to the skin being attached to the deep structures, so giving little opportunity for expansion. An early incision followed by hot fomentations is required.

Lipoma Nasi.

Lipoma nasi is not a correct name for the disease, which is an excessive development of the sebaceous glands, the ducts of which appear as deep pits. This is due to defective circulation, and is caused by anæmia or arises from alcoholic excess.

Measures are tried according to the origin, such as the administration of iron, the improvement of the digestion, or the reduction of the alcohol taken. When these fail, the redundant mass is excised, and the skin flaps on the two sides united in the middle line.

Fracture of the Nose.

The injury is from direct violence, causing a displacement backwards or to the side, according to the direction. Owing to the great swelling which quickly ensues, the nature of the accident has been often overlooked. An immediate reduction is necessary, for firm union takes place within a week.

Treatment.—The displacement is reduced under nitrous oxide gas, septum forceps, elevators, or the fingers being used. The bones may be kept in position by transfixing them with a hare-lip pin, and supporting the ends of the pin on the cheek by pieces of lint, or hollow vulcanite plugs may be inserted into the nostrils. Frequent irrigation and insufflations will be required to prevent necrosis.

When union with deformity has already taken place, judicious force, such as a blow with the fist, or a cut with a chisel or bone forceps through the nostril, is first necessary.

Plastic Operations on the Nose.

The nose may be destroyed by syphilitic or tubercular ulceration. It may be cut off, as still happens in Germany, during duels, and it was a current form of mutilation in the East.

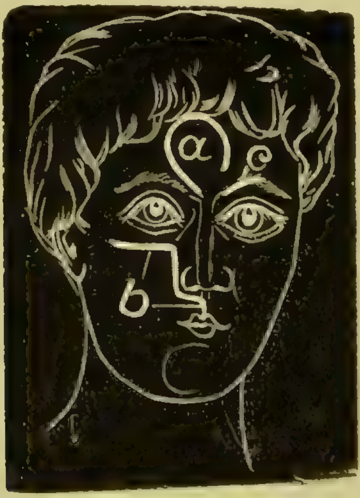


Fig. 57.—Lines of Incisions on Face.

a, Flap for plastic operations on the nose, supplied by the angular artery; *b*, excision of the upper jaw; *c*, opening of the frontal sinus.

After freshening the edges and surface, skin may be replaced by epidermal grafts, by skin grafts taken from some indifferent surface, by pedunculated flaps raised from the cheek or forehead, or by fixing the arm so that a pedunculated flap may be raised from the forearm and attached to the nose, the arm being finally freed by dividing the pedicle.

In order to restore the bony and cartilaginous framework, a flap is raised from the forehead, consisting of skin, periosteum, and the outer table, by means of a chisel. After turning the flap down, the surface left is covered by skin grafts (see Fig. 57, *a*). The anterior nares and columella are fashioned by skin flaps turned downwards and inwards.

Examination of the Nose and Naso-Pharynx.

The nose is examined directly from the front by means of a speculum and head-mirror, when the middle and inferior turbinals and the corresponding fossæ can be partly seen, as well as the septum.

The posterior nares are examined directly by the finger, which is hooked round the soft palate so as not to touch, if possible, the posterior wall of the pharynx; this is the only method for children. In adults the posterior nares are examined indirectly by a small mirror held in the naso-pharynx and illuminated from the head, the patient being encouraged to allow the soft palate to hang freely, or the soft palate may be hooked forwards. By this means the hinder part of the inferior, middle, and even the superior, turbinals are seen; the fossa marking the orifices of the Eustachian tubes and the hinder end of the septum are also in view, as well as the dome of the naso-pharynx.

The nose is lined by a bright-red muco-periosteum, very vascular owing to the number of small veins, and has an abundance of mucous glands, by which the air passing through is not only warmed, but moistened.

The mucous membrane is readily anæsthetized by 20 per cent. cocain applied on cotton-wool plugs; it is used, therefore, for all operations on the nose where a general anæsthetic is not required. Cocain also contracts the small bloodvessels, and so diminishes bleeding. A swelling which lessens in size on the application of cocain is a vascular one. Not more than 1 grain of cocain should be used at one time.

Foreign Bodies.

Buttons, etc., are frequently pushed up by children. A foreign body may be pulled out with forceps, caught in a snare, hooked out with a probe, or pushed back into the naso-pharynx when the head is hanging below the trunk. If it remains, persistent purulent discharge, with ozæna from the ulceration, is caused; and still later it may become encrusted with calcareous material and form a rhinolith.

Hypertrophic Rhinitis.

From repeated inflammations there ensues a chronic thickening with an excessive secretion of mucus.

Hypertrophy of Inferior Turbinal.—The mucous membrane covering the inferior turbinals may be specially affected, so that the nostril is blocked by a reddish mass. This is treated by saline douches, scored with a cautery, removed with a galvano-cautery snare after being partly cut through in front with scissors, or excised by a ring knife under an anæsthetic, the nose being afterwards plugged with gauze for a day. Douches and insufflations of boric acid, iodoform or tannic acid powders are used until healing.

Polypi.

Myxomatous degeneration of the mucous membrane is found on any part of the nose, but especially on the projecting middle and inferior turbinal. Polypi form pinkish-gray masses, not shrinking under cocain. In many cases no cause can be assigned. In a few cases there is ample evidence that they originate from ulceration and necrosis. In others the necrosis is apparently secondary to the polypus and the retention of discharges.

They are removed by the cold snare or forceps, by means of which the polypus and any dead bone attached is tugged away, or they are burnt with the galvano-cautery ecraseur, which destroys at the same time the pedicle, and so tends to prevent recurrence. Chromic acid fused on a probe is also applied to the base to prevent recurrence. Of the three methods, the most suitable for the particular case should be selected.

Any cause of suppuration, like disease of the antrum, must be also cured, or the polypi will return.

Hay Fever.

Pollen from the hay-fields acts as the exciting cause of profuse catarrh, including lachrymation, headache, and sneezing. There are, besides predisposing causes such as a nervous temperament or a tendency to asthma, congestion of the mucous membrane, the presence of an enlarged inferior turbinal bone, deviations of the septum causing nasal obstruction, also nasal polypi.

Congestion may be relieved by painting with cocain or menthol, or by dosing with quinine or antipyrin; the nervous condition by bromide of potassium, morphine, or belladonna; the profuse discharge by saline douches and the administration of atropine in doses less than sufficient to cause dryness of the throat.

The pollen is avoided by light cotton-wool plugs in the nostrils, by staying in town or going for a sea-voyage during haymaking; the conjunctival irritation and lachrymation is relieved by wearing green glasses and avoiding the sun.

Cauterization of the turbinals, rectification of a deviated septum, and removal of polypi, cure when the reflex irritation arises in this way. Local treatment may, however, prove merely palliative, and the chief attention has then to be directed to the general condition.

Atrophic Rhinitis.

Atrophic rhinitis is a wasting of the mucous membrane, with contraction of the bloodvessels and an atrophy of the mucous glands; so that the mucous membrane becomes pale and dry. The mucous membrane being thinner, much more of the nose can be seen from the front, including even the posterior wall of the naso-pharynx. It is often a consequence of hypertrophic rhinitis in childhood, which about puberty has passed over into the atrophic condition. It also originates, especially in young women, from anæmia. Black foul crusts form, stick on the mucous membrane, and set up ulceration, hæmorrhage, and ozæna. In advanced cases there is no cure; the treatment is only palliative.

It is prevented by treating hypertrophic rhinitis, and especially by re-establishing nose-breathing. When due to anæmia, a cure may follow on the return to good health. The local treatment consists of washes, saline for the simple ones, deodorants for the advanced cases, pledgets of wool soaked in the fluid being kept in the nostrils and frequently changed. Expectorants are given internally.

Ulcers.

Ulceration may follow the impaction of a foreign body.

Ulceration and Perforation of the Septum.—A round ulcer forms just within the nostril, due to the presence of crusts which are picked away with the finger. Dust causes this, especially irritating kinds, as in the manufacture of bichromate of potash. It is often accompanied by atrophic rhinitis. The ulceration goes on quietly to perforation without causing necrosis. It is treated by washes and mercurial ointment applied on the end of a probe.

Syphilitic Ulceration is congenital or has been acquired; gummata form in the muco-perichondrium; the cartilage is exposed and necrosis follows. It usually begins far back, and affects the vomer. It may go on to attack the bony framework of the nose, which then becomes depressed or eventually entirely destroyed; the soft and hard palate may be perforated, or an extension to the upper jaw on one or both sides may take place; the antrum is invaded, and more or less destruction of the superior maxilla follows. Iodide of potassium and mercury have to be given in full doses, combined with washes of permanganate, and all dead bone should be removed even before it separates and becomes loose. Thus, large pieces of the alveolar process may come away, and the antrum be widely exposed. There is always a danger of a septic extension to the ear, brain, neck, or lungs.

Tubercular Ulceration.—Tubercular disease is uncommon as a primary affection. It is seen generally as lupus extending from the face, without other signs of tubercular disease, but may occasionally accompany pulmonary phthisis. In the latter case tubercle bacilli may be found both in the floor of the ulcer and in the sputa. Painting with increasing strengths of lactic acid may improve slight cases; in severe ones scraping under an anæsthetic, and the free use of the cautery, form the only means of arresting the disease.

Diphtheritic Ulceration.—The signs of diphtheritic inflammation are a profuse muco-purulent discharge mixed with shreds of membrane and blood. It is generally due to extension from the fauces, but may be primary, the first evidence of the disease being hæmorrhage and the discharge of membrane. The complications to be feared are the extension to the middle ear and septic pneumonia.

For nasal diphtheria the nose must be syringed or sprayed hourly with boric acid or permanganate. The nose may be first wiped out with strong carbolic or sublimate solution. This local treatment must be carried out, however ill the patient. The disease is a dangerous one, and diphtheritic antitoxin is of great value in lessening its severity if the administration be begun early enough.

Epistaxis.

Local injury and ulceration are rarely the cause of more than a passing epistaxis. That from injury generally ceases spontaneously, and, if antiseptic powders are insufflated, does not recur. Ulcers—except malignant ones—if crusts are prevented from forming, are not difficult to treat.

When the bleeding is local, it is nearly always from a vessel on the septum just within the anterior nares. A plug of wool with iodoform may be inserted if the hæmorrhage has stopped. If bleeding is continuing, the nose may be pinched for a time, or, failing this, cocain is applied, and then the galvano-cautery, or a red-hot probe, or chromic acid. Recurring scabs are prevented by irrigation and ointment.

All the really important cases of epistaxis are connected with general causes, and may be divided into two classes—viz., those occurring in young people with anæmia, hydræmia, and weak vessel walls, and those occurring in older people from excessive vascular tension, in whom the epistaxis affords relief from the greater danger, apoplexy.

Belonging to the first class are the cases of hæmorrhage which complicate the acute specific fevers, purpura, scurvy, lymphadenoma, and hæmophilia. Iron and all measures to improve the general health are indicated, so as to ward off another attack, along with special care against septicæmia.

In the class of excessive vascular tension are cases of cirrhosis of the liver, granular kidneys, alcoholism, and chronic bronchitis and emphysema. Epistaxis in such patients serves as a warning, pointing to a less active life, a lower diet, little alcohol, and a daily evacuation of the bowels.

A case which is bleeding freely should lie on one side, with the head low if faint, or propped on a pillow, so that the blood shall run out of the anterior nostrils. The clots in the nose should not be disturbed. Ice is placed on the bridge of the nose. If the pulse is full, a quickly-acting purge is indicated. If the bleeding continues, a rubber bag is slipped up the nostril and inflated. This is usually all that is needed.

Plugging the Nose.—Cocain is first applied, then the finger is passed into the naso-pharynx, and a strip of iodoform gauze pushed into the nostril up to the finger; by pushing in more of the strip, the plug may be inserted to the necessary tightness. It is removed within twenty-four hours, and iodoform insufflated. Lint and perchloride of iron are of no further use, and do great harm by starting a dangerous septic ulceration. More elaborate ways of plugging the nose take longer and are less efficient.

Deviations of the Septum.

The deviations are usually congenital, but may be caused by an injury. The deviation is more commonly on the left side; it may be convex or sharply angular, or the lower end of the cartilaginous septum projects into the nostril. The projection becomes very tender from perichondritis, or an ulcer may form in contact with the inferior turbinal, or a cauliflower-like outgrowth of fibrous or cartilaginous material may form. Reflex symptoms result, respiratory difficulties, pain referred to other ends of the fifth nerve.

A convex deviation may be wrenched straight under nitrous oxide gas by flat-bladed forceps, aided by an elevator or the finger. A sharp projection is cut off with a saw if bony, or with the knife if cartilaginous, generally under cocain.

New Growths of the Nose.

A fibrous tumour is generally vascular, consisting of much nævoid tissue, consequently bleeding may occur. The slow and localized character of the growth is the best indication for diagnosis. After removal a careful microscopic examination must be made, especially of the base of the tumour. A benign growth is treated by complete excision, with cauterization of the base where necessary.

A malignant tumour is indicated by the rapidity of its growth and by the early hæmorrhage. A microscopical examination of a piece must be made at once. The tumour spreads to the upper jaw. Therefore an early and complete excision of the growth is necessary, and removal of more or less of the upper jaw may be required.

Operations for Exposure of the Interior of the Nose.

With the head hanging low, the soft with as much of the hard palate as necessary, is divided in the middle line. After excision of the growth the base is cauterized, and then the divided palate reunited. A plug of gauze is inserted so that it can be drawn out of the nostril.

A more severe operation is the raising of the upper jaw on one side whilst the nose is turned over to the opposite side. After excision, the remainder of the bone is replaced in position.

Other incisions give less space. An incision can be made between the gum and lip, with the division of the alar and septal cartilages.

A horseshoe-shaped incision is carried down the sides of the nose and across the lip beneath the nares. The nasal cartilages and bones are cut through at the sides, and also the septum in a direction upwards and backwards; the nose is then forcibly broken across at its base and turned up on the face. After careful suturing in position again, no deformity is left, and the scar disappears in a year or two. The nose has also been turned down by a horseshoe-shaped incision in the opposite direction.

Hypertrophic Inflammation of the Naso-Pharynx—Adenoid Vegetations.

Hypertrophy of the mucous membrane is the result of repeated catarrh in a weakly child, and is often started by scarlet fever or measles. It accompanies a similar condition in the nose, and the children get into the bad habit of breathing through the mouth. The air, not being warmed nor moistened by passing through the nose, keeps up the irritation of the pharynx.

The child appears to have always a bad cold; there is a muco-purulent discharge, which may be tinged with blood sometimes. It snores at night, is restless, and starts up during sleep. In an advanced case the power of pronouncing *m* and *n* in words like 'song,' 'common,' 'strangers coming up from the country,' is lost. Also the lower orifices of the Eustachian tubes are blocked, deafness is caused, and there may be retention in the middle ear of muco-pus, which may then perforate the drum. The child has a stupid aspect and keeps the mouth wide open. It is thin and anæmic, and its intellect is dull. On inspection the nose appears pinched in, and the anterior nares are very narrow. On depressing the tongue, a thickening of the fauces and a nodular condition of the pharynx is noted. The soft palate is thickened, is pushed forwards, and fixed, not being elevated during swallowing. A view may be obtained by the rhinoscope, but generally the diagnosis has to be completed by digital examination of the naso-pharynx, especially when an operation is under contemplation. The child's head is held by an assistant, the handle of an instrument is kept between the teeth to prevent the finger from being bitten. The finger slides along the soft palate, which it hooks forwards without touching the back of the naso-pharynx. Adenoid vegetations consist of soft papillomatous and nodular projections of the mucous membrane, blocking more or less the posterior nares.

At or about puberty an atrophy of the adenoid vegetations takes place, along with atrophic rhinitis and its attendant evils. A patient who has acquired the habit of breathing through the mouth still continues to do so, although the nose is no longer blocked. In addition the patient suffers from chronic laryngitis.

Chronic hypertrophy of the tonsils very often accompanies adenoid vegetations.

Treatment of Hypertrophic Inflammations of the Naso-Pharynx and of Adenoid Vegetations.—In slight cases the iodide of iron is administered, and nose-breathing enforced, especially at night. These measures, along with good food and fresh air, will often suffice. Removal of the tonsils has also a good effect in promoting recovery in all except marked cases.

Removal of Adenoid Vegetations.—An operation for the removal of adenoids becomes necessary when the symptoms have persisted some time in spite of treatment. It becomes urgent when the child's education is hindered by the disease. A thorough removal under a general anæsthetic is the only method worthy of consideration. The scraping with the finger of the naso-pharynx of a non-anæsthetized child is not only useless but objectionable. Cocain is not of any service except in comparatively rare cases for adults with limited growths. Nitrous oxide gas, followed by a little ether, is the best anæsthetic, although there is no objection to chloroform in young children. In no case should the patient be deeply anæsthetized, lest the laryngeal reflexes be impaired. All that is necessary is to anæsthetize the patient sufficient for the insertion of a gag; the child's head is then turned to one side, the surgeon inserts a finger of the left hand behind the palate, and with the special forceps seizes and pulls away the largest masses. The posterior edge of the septum must be avoided, but the hinder ends of the inferior turbinals are plucked away when enlarged. The operation is then completed by scraping the back of the naso-pharynx and the region of the Eustachian tubes with the curette. All this should take but two or three minutes, whilst the blood should run out of the lower angle of the mouth. The nose is then pinched, the pharynx wiped out with sponges on holders, and the gag taken out. At this time the patient should be coming out from the anæsthetic.

The patient is kept in bed for a day, and, unless the temperature rises, can then get up. Soft food is given for a few days. No topical applications should be employed for young children.

Complications of the Operation.—The chief danger is in connection with the anæsthetic. Indigestible food may be vomited during or immediately after the operation, and get into the larynx. Blood may get into the larynx if the patient is deeply anæsthetized. Septic infection may be inoculated by fingers or instrument. The discharges from dead bone in the middle ear may flow down the Eustachian tube, or pus from necrosis in the nose may infect the raw surface left by the removal of the adenoids. Dead bone in the ear and nose should be vigorously treated before and after the operation; there is an increased risk in removing the adenoids, and a fatal septicæmia has followed.

Recurrence of adenoids is avoided by a thorough operation, by insisting upon nose-breathing, and by not operating upon very young children until other measures have been well tried.

Chronic Pharyngitis.

This may occur from lack of nose-breathing, atrophic rhinitis, overuse of the voice, or tobacco-smoking, and may be improved by the removal of the cause.

Granular Pharyngitis.

Small lymph nodules form on the naso-pharynx, especially of adults, and may be treated by touching them with the cautery point after astringent applications have failed.

Syphilitic Ulceration of the Pharynx

may go on to almost or complete closure, separating the nose from the pharynx. It is difficult or impossible to prevent this. Adhesions may be separated, or prevented by pulling the soft palate forwards with a hook. This relieves Eustachian obstruction, and laryngitis due to mouth-breathing.

Tubercular Ulceration of the Pharynx.

In its chronic or lupus form it may be treated by curetting and lactic acid after cocainization.

The more rapid forms are secondary to lung affection, and attempts should be directed mainly to the relief of pain or cough.

Naso-Pharyngeal Polypi.

Mucous Polypi.—The polypi grow from the hinder end of the turbinals, from the septum, and from the margins of the posterior nares. They cause nasal obstruction without hæmorrhage, appear as bluish-gray masses, which are soft and pedunculated to digital examination.

They are removed under cocain or nitrous oxide gas by seizing and tugging them away with adenoid vegetation forceps, or by means of a galvano-cautery snare, the loop being passed back through the nose and slipped over the polypus by the aid of the finger behind the palate.

Fibrous Polypi.—These polypi are sarcomata, and grow from the periosteum ; they are vascular, having large veins over the surface and around their insertion, which is broad. Bleeding is an early sign along with nasal obstruction ; the soft palate is pushed forwards and the growth hangs below it. Fibrous polypi are removed from the naso-pharynx by placing the patient with the head over the end of the table, dividing the soft palate, and holding the sides apart with silk. The polypus is then detached by a periosteal raspatory or by the cautery blade. The bleeding is free and venous. It is checked by sponge pressure ; then the naso-pharynx is plugged, and the ends of the gauze strips passed out through the nose. The palate is finally sutured.

In the worst cases it is better to do a preliminary tracheotomy and plug the pharynx ; but as a rule the head hangs low, and the blood runs out of the nose. The plugs are removed the next day, after which iodoform is insufflated frequently.

Encephalocele.

Encephalocele is congenital in origin. The dura mater, containing brain matter, protrudes through the base of the skull and forms a whitish tumour, which fills the naso-pharynx or the nose, out of which it may protrude. As a congenital malady it is seen in young children. On palpation, pulsation and a cough impulse are felt.

Encephalocele is left alone. Above all things, it must not be mistaken for a mucous polypus and be hastily plucked away. There ought to be no danger of this mistake being made, for a simple mucous polypus is not seen in children.

Empyema of the Antrum of the Upper Jaw.

An empyema forms with or without polypi in the nose, and is generally secondary to disease of the teeth or of the nose. Pain and swelling of the cheek, with the escape of pus from the nose, are the general signs. The nose may

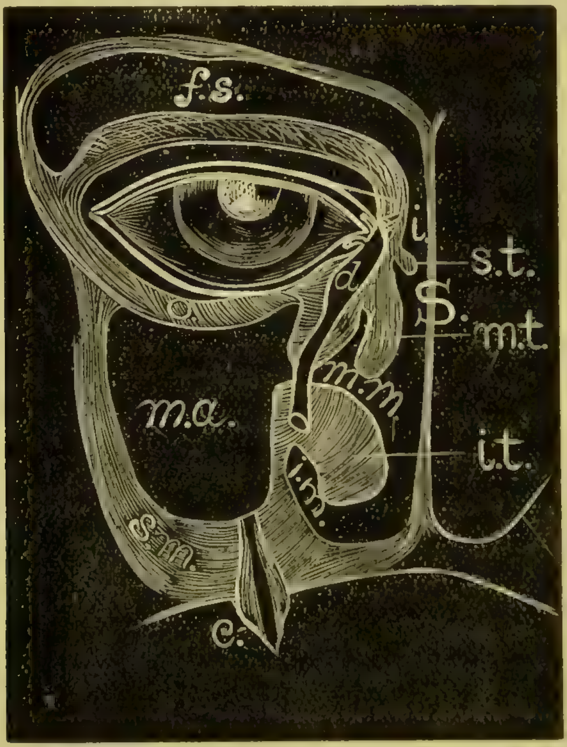


FIG. 58.—DIAGRAM OF NOSE AND SINUSES CONNECTED WITH IT.

s m, Superior maxilla; *c*, canine tooth; *o*, orbit; *S*, nasal septum; *s t*, *m t*, *i t*, superior, middle, and inferior turbinals; *m m*, *i m*, middle and inferior meatus; *m a*, maxillary antrum; *d*, lachrymal sac and nasal duct; *fs*, frontal sinus, full extent; *i*, infundibulum.

be wiped out, and the patient then told to bend forwards, by which means pus escapes into the middle meatus. The diagnosis is completed by transillumination. If the antrum be occupied by pus or by an opaque tumour, an electric lamp held in the closed mouth in a dark room will illuminate the sound cheek and pupil, leaving the pupil on the diseased side unilluminated and the cheek more or less in shadow, especially below the eyelid. Pus may also be removed through an exploring syringe, the needle being pushed through the outer wall of the inferior meatus after cocainization.

Treatment.—The antrum may be perforated through a tooth-socket, especially a canine or bicuspid; a cannula may then be passed daily and the cavity washed out. In order to meet the difficulty of closure, the cannula is best kept *in situ*, being fixed on a dental plate; it can be kept closed against food by a split plug.

For a permanent cure, especially when there are polypi, the antrum is opened through the canine fossa wide enough to admit the finger; the mucous membrane and polypi are then scraped out with a sharp spoon, and the interior plugged with gauze for twenty-four hours. This wide opening does not quickly close; it can be irrigated frequently by the patient, and the tongue learns to keep food out during mastication. The mucous membrane is soon restored, to look like that lining the nose. A counter-opening can be made through the inferior meatus so as to be more nearly level with the floor of the antrum than the normal foramen.

A neglect of this treatment results in extensive necrosis, a perforation on the cheek, cellulitis, pyæmia.

Tumours of the Upper Jaw.

Bony Tumours.—These are of slow growth, occasionally single, more often multiple, forming in the distribution of the fifth nerve, and called leontiasis ossea or multiple exostoses.

The sole indication for removal is in order to relieve pain.

Myeloid Sarcoma.—A tumour of the jaw growing slowly for a year or more, and gradually bulging the cheek without affecting glands, is most likely a myeloid sarcoma. An exploration may be made from the mouth to confirm the diagnosis.

Treatment.—The removal of the upper jaw will probably cure in the case of a myeloid sarcoma.

Epithelioma.—Cylindrical and squamous-celled tumours begin in the antrum from the mucous membrane, and extend rapidly towards the mouth, nose, orbit, sphenoid and ethmoid bone, and to the lymphatic glands. A removal of the upper jaw does not, therefore, remove the whole disease unless in very early cases. Hence reappearance of the growth is common.

Removal of the Upper Jaw.

An incision is made from the malar bone along the lower border of the orbit to a point just below the inner canthus, then down the groove between the nose and the cheek round the ala, and ending by a vertical cut through the centre of the upper lip. The lip and cheek are raised and turned back, and the bleeding stopped.

The patient may now be put in one of two positions—either with the head hanging over the table or well propped up in a half-sitting posture. In either case he should be in a superficial stage of anæsthesia, so as to be able to keep blood out of his larynx. Three cuts are next rapidly made with bone forceps, one through the outer angle of the orbit, one between the nose and orbit, and the third along the middle line, dividing the alveolar process and the palate. The soft palate is first cut through with a knife or scissors, and the central incisor tooth of that side extracted. The bone is then seized with lion forceps, and by lateral and vertical movements, aided, if necessary, by leverage exerted by an elevator, the upper jaw is rapidly torn out, and a sponge forthwith thrust into the cavity. Branches of the internal maxillary are ligatured, and hæmorrhage from veins and the bone is stopped by sponge pressure, antiseptic wax, or the cautery. The cavity is dressed with iodoform and gauze, and the cheek exactly united. After twenty-four hours the plug is removed, the cavity is frequently washed out and iodoform insufflated. The danger of the operation lies in the sudden shock and loss of blood, and from blood flowing into the larynx. To shut off the nose, a flap may be turned down from the inner surface of the cheek and united to the remaining half of the hard palate.

Removal of the Alveolar Process only.—This may be sufficient if the tumour involves only this part of the bone. By it the orbital plate remains untouched. The lip is separated from the gum and retracted, and two cuts are made with bone forceps, one horizontal from the nose outwards well above the alveolar process, and one vertical in the middle line through the alveolar process and palate as before.

The Frontal Sinus.

The degree of development of the frontal sinuses varies greatly : they may extend outwards to the external angle of the orbit on each side, and may communicate across the middle line.

Empyema.—They are commonly affected by suppuration owing to extension from the nose, and become full of polypi from degeneration of the mucous membrane. A discharge of pus into the nose alternates with retention. During the latter stage there is frontal headache, and œdema of the forehead and eyelids with fever, which is temporarily relieved by a discharge of pus from the nose. Pus may appear subcutaneously, and air may get into the abscess from the nose and form a pneumocele, or emphysema may spread.

Irrigation through the infundibulum, with removal of the anterior part of the middle turbinal, is first tried. If it is insufficient, a horizontal incision is made just in the line of the eyebrow, all the sinus is exposed, the whole of the degenerated mucous membrane removed, and the cavity dressed with iodoform and gauze ; free opening is made into the nose, and the wound on the forehead sutured.

Tumours.—Cartilaginous and osseous tumours arise in the sinus, causing a bulging forwards, or backwards with cerebral symptoms. Some are easily shelled out.

CHAPTER XX.

SURGERY OF THE FACE.

Face Wounds.

ALL face wounds should be exactly united with horsehair. Healing follows, and leaves a linear scar. Puckered scars result from wounds which have not been united, or where the skin has been destroyed by burns or lupus. This last cause can be prevented by the transplantation of epidermis as soon as a healthy granulating surface has formed, so that in most cases the necessity for plastic operations is avoided.

Ulcers.

Tubercular Ulceration, or Lupus.—This appears in children or young people before puberty. It may exist alone, or there may be enlarged glands in the neck or other tubercular forms of disease. The first noticeable condition is an eczema. It may be on both cheeks or in irregular patches. Next gelatinous papules form, which ulcerate. The ulcer continues to extend, the older parts of the ulcer healing with scarring. The destruction of the lips or nose may follow, with cicatricial contraction. After puberty the disease may come to a standstill, but only when much damage has been done, or an extension of the tubercular process steadily continues.

Treatment.—Mercurial ointment is used for the eczema; scraping, or the cautery point, is applied wherever points of softening occur. When the ulcer is extensive, scraping of all soft structures, followed by a searing with the cautery, is used; or, instead, caustics like chloride of zinc, or strong antiseptics like pure carbolic acid, rubbed in and then washed away. But the most satisfactory procedure is the excision of the patch of lupus, and the covering in of the surface left by epidermal grafts, and this should be done wherever possible.

Syphilitic Ulceration—Tubercular Syphilide.—In young subjects this is due to inherited disease. The chief distinguishing feature between syphilis and tubercle is the greater rapidity in the former case. Signs of either disease in other parts aid in confirming the diagnosis. The acquired form occurs in older persons than those who suffer from tubercle. Very active treatment with iodide of potassium and mercury may be required in order to save the face and nose from destruction.

Rodent Ulcer—Crateriform Ulcer.—The epitheliomatous ulcers on the face grow singularly slowly, and do not affect the glands. The commonest site is just below the inner canthus of the eye, from which the ulcer may spread superficially with only a faintly indurated margin. More rarely the ulcer digs deeply into the face, and has more induration, hence the term crateriform ulcer. All the structures in the skin, the sebaceous glands, the sweat glands, the hair follicles, and the epidermis, have been accused of starting the disease, the sebaceous glands the more frequently. If not removed, the ulcer slowly extends, until, after years, it exposes the brain or opens into a large vessel and causes repeated hæmorrhage. An early and wide excision may cure. The incision must be at least ¼ inch from the outermost margin of induration. Skin-grafting or plastic operations may be needed to cover in the wound.

Nævi.—Nævi are excised, and the skin brought together; or electrolysis may be applied in several sittings.

Hairy Moles are excised.

Redundant Hairs are removed by electrolysis, using a fine sewing needle on the negative pole passed down into each hair follicle, whilst the positive pole, attached to a sponge wetted with salt and water, is grasped firmly by the patient. A sufficient current is used, so that bubbles rise up by the hair, and in about ten seconds the hair bulb and all can be drawn out without leaving a scar.

Port-Wine Stains.—They may be seared so as to destroy the vessels, and afterwards tattooed with pigment, to resemble the rest of the skin. When limited, excision and transplantation of skin is done.

Facial or Trigeminal Neuralgia.

Local causes in the nose, eye or mouth, also general causes, such as anæmia, syphilis, or malaria, must be first excluded.

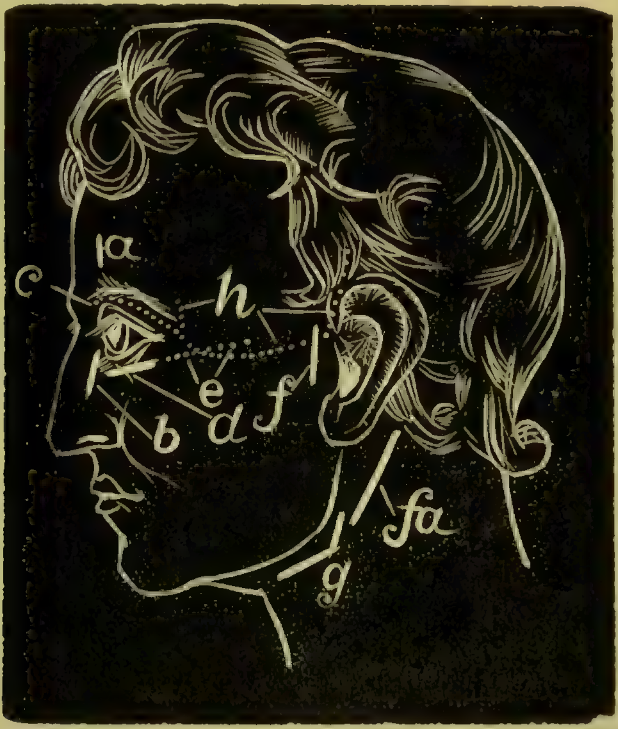


FIG. 59.—LINES OF INCISION FOR EXPOSING NERVES.

Ophthalmic division: *a*, vertical incision for the supra-orbital nerve; *b*, vertical incision for the infratrochlear nerve; *c*, curved horizontal incision for the ophthalmic division in the roof of the orbit. Superior maxillary division: *d*, horizontal incision for infra-orbital nerve; *e*, continuation of *d*, for superior maxillary division at the foramen rotundum. Inferior maxillary division: *f*, vertical incision for auriculo-temporal nerve; *g*, curved incision, behind angle of lower jaw, for inferior dental and lingual nerves; *h*, curved incision for inferior maxillary division at the foramen ovale, also for exposure of Gasserian ganglion; *fa*, incision for exposure of facial nerve.

The Smaller Branches of the Fifth Nerve.—The supra-orbital nerve is exposed just above the notch by a vertical or horizontal incision.

The infra-orbital nerve is exposed by a horizontal incision over the foramen, just below the margin of the orbit.

The infratrochlear division is exposed by the side of the nose by a longitudinal incision.

The auriculo-temporal nerve is found immediately behind the temporal artery by a vertical incision in front of the tragus down to the zygoma.

The inferior dental and lingual nerves are exposed by an incision behind the angle of the jaw. It extends as far forwards as the facial artery, but is continued up along the posterior border of the vertical ramus for only $\frac{1}{2}$ inch, above which the incision must only divide skin, so as to avoid injury to the branches of the facial nerve. The masseter is then detached from the bone by a raspatory, and the vertical ramus trephined in its centre, thus exposing both nerves.

The lingual and inferior dental can be exposed from within the mouth by fully opening it, feeling for the sharp anterior edge of the vertical ramus, cutting down upon it, separating the periosteum from the inner surface, and feeling for the spine marking the inferior dental canal. The lingual nerve lies on the inner side, and the inferior dental nerve behind the spine. The lingual nerve lies just beneath the mucous membrane, between the anterior pillar of the fauces and the root of the tongue, and can be felt by pulling out the tongue to the opposite side.

The Three Divisions of the Fifth Nerve.—*The Ophthalmic Branch* is exposed in the roof of the orbit by a horizontal incision through the upper eyelid, and following back the supra-orbital branch. The nerve is then wound up on clamp forceps, and so drawn out.

Superior Maxillary Division and Meckel's Ganglion.—The nerve is divided at its exit from the foramen rotundum. The incision is an extension of that for the infra-orbital nerve outwards over the malar bone to the zygoma. The outer angle of the orbit, the malar process of the upper jaw, and the malar bone are resected and drawn outwards. Then the infra-orbital nerve is traced back along the canal in the floor of the orbit above the antrum, which may have been opened, to the foramen rotundum. The nerve is divided and torn out along with its palatine branches.

The Inferior Maxillary Division is exposed at the foramen ovale. A curved incision is made from the external angular process, downwards along the zygoma and upwards in front of the ear; the zygoma is resected and turned down; the temporal muscle is detached from the skull downwards by the raspatory, and the great wing of the sphenoid followed as far as the base of the pterygoid process. The foramen ovale lies close behind its sharp posterior edge. When more room is required, the tip of the coronoid process is divided. Branches of the internal maxillary are clamped and tied. The middle meningeal lies behind, and may be avoided. By a little extension of the incision forwards, the superior maxillary division may also be removed at the same time.

The Gasserian ganglion is reached by an extension of the foregoing, the skull being trephined close to the foramen ovale; or the squamous portion of the temporal bone may be removed, the dura raised, the middle meningeal artery tied, and the portions of the ganglion with the second and third divisions removed. The ophthalmic portion of the ganglion cannot generally be removed, or the cavernous sinus would be torn. The operation may have to be interrupted for a week on account of hæmorrhage. The eyelids must be stitched together before the operation, after which the stitches are removed, and the cornea is protected by a watch-glass or celluloid plate held in place by strapping.

Facial Spasm—Tic-douloureux.

The facial nerve may have to be stretched for painful spasm of the muscles. It should certainly not be resected or torn out at the first operation, on account of the paralysis and disfigurement following. An incision is made from the base of the mastoid process to the angle of the jaw, and the lobule of the ear is freed and hooked up. The anterior border of the sterno-mastoid and of the posterior belly of the digastric is made out, with the external carotid just beneath. The anterior border of the mastoid process is defined, and just above the attachment of the digastric the nerve comes forward, reaching the ramus of the jaw about midway between the joint and the angle. From this point the various divisions spread to the face immediately beneath the skin.

Although paralysis and disfigurement follow the division of the facial nerve, yet the operation is advisable in severe cases, for many patients who have not been relieved by this means have been driven by pain to commit suicide.

Malar Bone.

A swelling over this prominence, if from direct violence, is generally a hæmatoma. It is only very rarely that the malar bone is fractured, and when it is there is no displacement.

Syphilitic periostitis of the malar bone produces a painful swelling, and causes œdema of the eyelids and cheek.

Lachrymal Sac.

Mucocele.—A soft swelling below the inner canthus of the eyelid, in the groove between the nose and cheek, the skin being free, is a mucocele or the collection of fluid in the lachrymal sac. It indicates obstruction of the nasal duct below, and is cured by dilating the duct.

Lachrymal Abscess.—This follows on obstruction. The swelling becomes tender and the skin inflamed. The latter feature is often so well marked, and causes such redness and œdema around, that it can be easily mistaken for erysipelas. The pus extends very quickly from the sac to the bone, and sets up necrosis; it likewise bursts through the skin, and the result is a lachrymal fistula, kept up by necrosed bone and by the obstruction of the nasal duct. It is important that the abscess should be punctured early with a tenotome just below the tendo oculi.

Parotid Gland.

Excessive secretion, mercurial or otherwise, is reduced by atropin. Xerostomia, or dry-mouth, and other causes may temporarily block the ducts and lead to a swelling of the gland.

A calculus may form in the duct and cause a painful hard swelling. It is removed from within the cheek if possible. Less often there are several calculi, which set up suppuration, the parotid abscess bursts, and small calculi are discharged. An obstruction cyst may form in the course of the duct, which should, if possible, be opened through the mouth.

Parotid Fistula.—It is due generally to a wound, less commonly to an abscess opening on the face. The secretion no longer passes along the rest of the duct, but is poured out on the face, where it can be recognised as a thin mucous fluid acting on starch—the outflow accompanying mastication.

The sooner treatment is adopted, the better. The orifice of the duct is sought for in the mouth, and the duct slit up as far as or just beyond the fistula on the face, so that the secretion reaches the opening into the mouth before it does that on the skin. The latter is pared, united by horsehair, and covered with collodion; whilst the slit on the inner surface is kept open by passing a probe along it daily.

Acute Inflammation.—Acute parotitis is commonly due to mumps, and is then bilateral, although the second gland may begin to swell some few days after the first. An acute primary abscess only occurs in connection with calculi, or from lymphatic glands suppurating amongst the lobules.

Secondary Parotid Abscess.—This is due to pyæmia, and is generally unilateral. It not only occurs in typical cases of pyæmia, but in more obscure ones arising after abdominal operations and disease, operations on the ovary, excision of the prostate, stricture complications, and even after rectal feeding.

The condition is very grave. A number of foci suppurate without at first communicating. An incision must be made as soon as it is seen that hot fomentations and belladonna, etc., do not relieve; then the gland should be as much as possible scraped away with a sharp spoon.

The incision is made horizontally, so as not to injure the facial nerve, and if the incision is in front of the posterior border of the jaw, there is no danger of wounding the artery.

Parotid Tumours.—The simple parotid tumour is at first benign, and encapsuled. It has a mixed structure—fibrous, cartilaginous, and glandular. It grows slowly for years, yet it may be assumed that it will finally become malignant.

The malignant parotid tumours are chondro-sarcomas or carcinomas, which infiltrate part, and soon the whole, of the gland. The tumour is therefore fixed and not encapsuled. The facial nerve fibres tend to be paralyzed by infiltration, whereas in a simple tumour they are only pushed aside.

Simple tumours are easily shelled out through a horizontal incision, the facial nerve fibres being retracted.

A small malignant tumour may be treated by wide excision ; if the wound is large, the artery can be easily tied if divided. If possible, the facial fibres are avoided ; but if divided, they should be reunited before closing the wound.

Deeply-seated and fixed tumours should be avoided, as it is impossible to remove the whole of the parotid gland.

CHAPTER XXI.

SURGERY OF THE LOWER JAW.

The Joint of the Lower Jaw—The Temporo-Maxillary or Mandibular Articulation.

THIS joint has the following peculiarities: Fixation of one joint prevents all movements of the lower jaw; a fibro-cartilage separates the joint surfaces, which may become displaced so as to limit movement; the joint is a hinge held at the sides by ligament, prevented from being displaced backwards except by violence sufficient to fracture the wall of the external auditory meatus, but only limited as to depression by muscles, and hence a dislocation forwards is predisposed to by muscular relaxation.

Abnormality.—A disturbance in the formation of the mandibulo-hyoid arch at its upper end may be unilateral or bilateral, and is attended by defects in the formation of the external and middle ear, the Eustachian tubes, and the body of the lower jaw.

Injury to the Joint.—This has been done by the forceps during birth. Fracture of the head or neck communicating with the joint is very rare. In any case, free movement must be maintained from the first.

Dislocation of the Lower Jaw.

Dislocation is especially brought about by muscular debility. Hence it occurs in young women who are weak and anæmic. It also happens in edentulous women, following upon atrophy of the jaw. The excessive depression, which is the immediate cause, occurs in laughing, yawning, and shouting, in the course of tooth extraction, or in using a gag. The dislocation is forwards, and may be unilateral or bilateral. In adult men dislocation is due to direct violence. Thus, a blow from behind may drive the head of the bone forwards, a blow in front backwards, fracturing the wall of the external auditory meatus.

In the dislocation forwards, the head of the bone lies in front of the eminentia articularis, the mouth is partly open. The lower jaw is advanced when the dislocation is bilateral, and deviated to the opposite side when unilateral; the patient cannot articulate nor swallow well.

Reduction of the Dislocation.—The reduction is made by pressing with the thumbs on the horizontal ramus of the jaw in the mouth just behind the molar teeth, whilst the chin is raised with the fingers. If this fails, the pressure should be made on the coronoid process, which can be felt projecting on the inner side of the cheek, wedged underneath the zygoma. An anæsthetic may be given or not; it makes little difference.

If a dislocation be unreduced, only slight movement is regained. The mouth cannot be opened for more than an inch, and the grinding movement is lost. The joint must be incised, and the bone replaced after adhesions have been divided; but the head of the bone may require excision.

Subluxation.—This is due to a displacement of the intra-articular fibro-cartilage, so that the jaw becomes locked. Reduction may be made by forcible movement, but there may be recurrence. If so, the cartilage should be sutured in position through an incision.

Recurrent Dislocation.— This may be generally prevented by fixing the intra-articular cartilage, which will be found very movable, and by taking care not to open the mouth widely.

Arthritis.

Acute Septic Inflammation of the Joint is secondary and pyæmic in origin—*e.g.*, after scarlet fever—or it may extend directly from the ear. Incision and early movement prevent fixation.

Subacute and Chronic Inflammation may follow the acute form, or be rheumatic, gonorrhœal, or gouty in origin.

Arthritis Deformans, whether due to locomotor ataxia or to rheumatism, greatly distorts the joint. Attention must be paid to keeping up free movement in all chronic cases.

Stiff Jaw.

Reflex Spasm is commonest from the lower last molar, owing to abnormalities in eruption in young people soon after puberty. It is relieved by extraction either of the third molar or of the second ; in the latter case the third is released, and so becomes erupted.

Central Spasm may originate from some professional neurosis, such as from much speaking. Its most serious form occurs in tetanus, in which it is tonic ; in strychnine-poisoning, in which it is clonic ; and in epilepsy, in which it is first one and then the other, so that if the jaw be suddenly closed at the moment that the tongue is protruded, the latter is bitten.

Secondary Ankylosis may be intrinsic in origin, at first fibrous, then bony from the causes above given. Following acute or chronic inflammations, the condyle is simply fixed, or is first partly destroyed by disease. In arthritis deformans there is a great enlargement of the condyle, with a corresponding widening of the articular surface on the temporal bone. Ankylosis of the jaw is prevented by free movement early in the disease ; later on forcible movement under an anæsthetic is needed, for the slow enlargement of the mouth by means of a screw gag is not well borne. If there is a great tendency to return to the fixed state, a dental prop is fixed in the mouth for a portion of each day. When these measures fail, the condyle is incised or a false joint made. Secondary ankylosis, when extrinsic, is caused by burns destroying the skin, or by phagedena attacking all the structures of the cheek. The contractures may be prevented by skin-grafting. When the contractures have formed, forcible opening is combined with a division of bands and with plastic operations.

Operation for Ankylosis.—The joint may be exposed by an incision over it, which should not extend far enough back to wound the temporal artery. If made vertical, the incision should not be carried far enough downwards to wound the parotid duct. After the vertical incision has been made through the skin, the horizontally-running fibres of the facial nerve should be retracted, so as to avoid paralyzing the muscles of the lower eyelid. The horizontal and the vertical incision can be combined in a T-shaped incision.

Excision is never an easy operation. Great care is needed in separating behind to avoid injury to the internal maxillary artery, for it may be difficult to tie, and the wound may have to be plugged. The condyle may have to be chipped away piecemeal, or it may be impossible to remove it for fear of injuring the thin plate separating it from the middle cerebral fossa. If this be so, enough of the neck must be resected to make a false joint. After union, free movement is kept up. In some cases this has been impossible, either because after excision little movement has been obtained, or fixation has quickly returned, or it has been impossible either to excise the condyle or the neck on account of bony masses. In such cases, a wedge-shaped piece may be excised from the angle of the jaw on one or both sides, by means of which an opening of the mouth to the extent of an inch or more may be gained.

Rami of the Lower Jaw.

The lower jaw being in close relationship with the mouth, it may be affected secondarily, such as by the extension of malignant disease from the tongue. More frequently still disease of the teeth affects it.

Fracture is most common about the middle of the horizontal ramus, where the bone is weakened by the long canine alveolus. It is due to direct violence, especially to blows. The hinder fragment is now mainly acted on by the muscles closing the mouth, that in front by the depressors of the lower jaw. There need not be any displacement; but if there is displacement, the distal fragment gets below the proximal. When the fracture is on both sides, the chin piece has been markedly drawn down.

The fracture is practically always compound into the mouth, for the muco-periosteum forming the gum is firmly fixed to the bone, and tears with it. The line of fracture is generally vertical; it may be comminuted, a tooth may get between the fragments, and necrosis ensue with the discharge of sequestra. Bleeding from the inferior dental artery is hardly ever severe, owing to the artery being torn across. Rupture of the nerve produces anæsthesia of the corresponding lip, gum, and teeth.

In an alcoholic patient fatal septic inflammation may spread from the fracture to the neck.

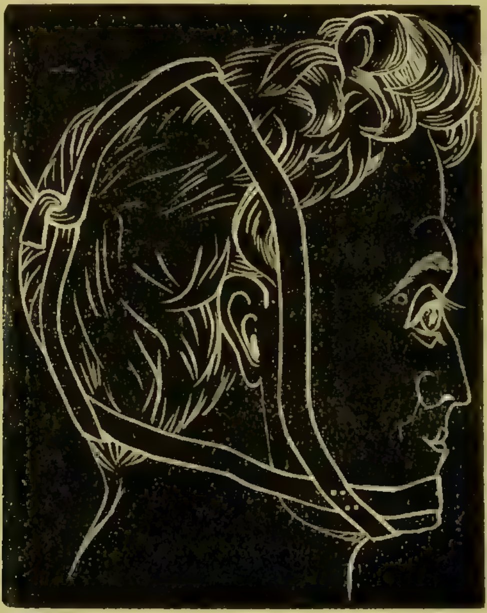


FIG. 60.—FOUR-TAILED JAW BANDAGE.

Treatment.—The following is in order of complexity:

1. Closure of the jaw and a chin bandage, with care not to use the jaw for hard biting for a month, and the use of permanganate solution as a mouth-wash.

2. Reducing and fixing in position by silver wire twisted round adjacent teeth on either side of the line of fracture.

3. The moulding of a cardboard, gutta-percha, or leather splint to fit on beneath the chin bandage.

4. A dental splint fitted on after taking a cast of the mouth.

5. Fixing of the sides of the fracture by silver wire passed through holes bored in the bone.

Necrosis may be secondary to suppuration in connection with the teeth, or following on a compound fracture. Necrosis follows phosphorus or mercury poisoning, or from scurvy. It may follow one of the specific fevers in childhood. Until inflammation has subsided mouth-washes are used. Then by gouging or subperiosteal resection the dead bone is removed, exfoliation being generally too tedious a process to be waited for.

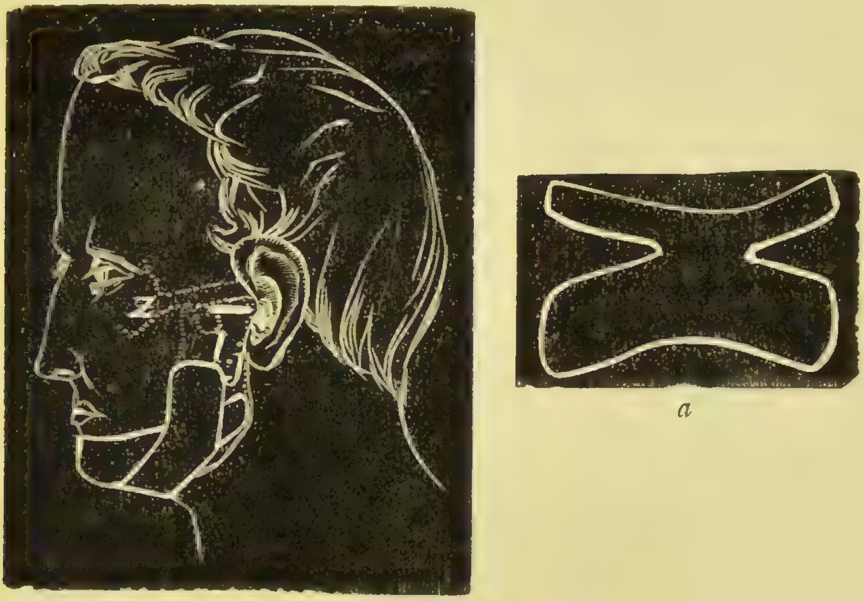


Fig. 61.—Jaw Splint.

a, Pattern; *lj*, lower jaw, jaw splint applied; *z*, zygoma. Horizontal line shows the incision to expose the joint.

Actinomycosis of the Jaw is not often seen in this country. A tumour with discharging sinuses leading to bare bone may be found, which yields pus containing small yellow grains, which on microscopic examination show the fungus. The sinuses are treated by erasion, strong antiseptics, and by iodide of potash internally.

Tumours of the Lower Jaw.

Dentigerous Cyst.—A slowly-forming tumour, due to a smooth enlargement of the jaw, may finally come to have so thin a shell that it crackles beneath the finger. It can be only diagnosed from central or myeloid sarcoma by puncture or incision. A tooth may be noted as absent from the full number, or the dentigerous cyst may arise in connection with a supernumerary tooth socket.

By an incision below the margin of the jaw, a smooth-walled cavity is found which contains a tooth. The tooth is extracted, the wall scraped, the bony wall broken in or chipped away, and the wound is filled daily with gauze.

Myeloid Sarcoma.—A central tumour slowly develops, and the compact bone of the jaw is expanded and thinned until it gives a crackling sensation to the touch. As the shell is perforated the tumour becomes softer; it then extends outwards to the neighbouring muscle and glands. When the tumour is cut down upon, it is found that a section of the solid portion has a maroon colour, resembling the colour of the heart. Myxomatous degeneration causes a cystic cavity in the interior. If the tumour is circumscribed and consists mainly of broken-down tissue, it is scraped away. If the tumour is firm, and especially if the shell is perforated, the affected portion of the jaw must be cut through with bone forceps on either side of the tumour. This is a quicker method than sawing; no splintering takes place, and the bone is not so likely to bleed. If the glands have become affected and are widely excised, a good prognosis can still be given; on microscopical examination abundant giant cells are found.

Osteomata, simple or multiple, are recognised by their slow growth and osseous nature, both on palpation and on boring. The question of removal depends on the amount of deformity and pain occasioned. A recurrence in the multiple cases, leontiasis ossea, may be looked for.

Cystic Epithelioma.—This tumour arises from the dental alveoli and spreads into the jaw, causing a gradually increasing thickening and an enlargement of lymphatic glands. The teeth having been extracted without arresting the growth, it should be cut into, when on section a honeycomb-like appearance, due to a number of small cysts with a fibrous stroma between, will be found.

A wide excision should be made by cutting through healthy jaw on either side, and removing neighbouring lymphatic glands, with the lymphatics leading to them.

Periosteal Sarcoma begins by a thickening of the jaw, rapidly grows, spreads to adjacent lymphatic glands, and then to the internal organs.

It is only after a very early excision of the whole ramus of one side that any hope can be entertained of cure. A partial resection will certainly be attended by continuance of the growth in the bone. Removal, although apparently complete, can only be considered as palliative; if the disease is of longer duration than three months, recurrence will take place in the neck or in internal organs.

Excision of the Lower Jaw.

Removal of One Half of the Lower Jaw.—(1) An incision along the lower border of the jaw, from the chin to the angle, and half-way up the vertical ramus, but not further, or it would injure the parotid duct or facial nerve. (2) The separation of the cheek from the jaw. (3) The separation of the floor of the mouth from the same. (4) The symphysis is cut through. (5) The bone is depressed and everted whilst dividing the capsule of the joint and the pterygoid muscles, avoiding the internal maxillary artery as it passes close behind the neck of the condyle.

The whole wound may be sewn up, and a permanganate mouth-wash and iodoform used frequently; or a drain may be inserted at the lowest point, especially when glands have had to be excised.

CHAPTER XXII.

SURGERY OF THE MOUTH.

The Lips.

Wounds of the Lip are either contused, by being driven against the teeth, or incised. If exactly united, healing readily occurs. The sutures through the skin involve two-thirds of the thickness, but avoid the mucous membrane, which is separately sutured from within. When there is tension, silver wire or hare-lip pins are used, and further support is given by applying strapping.

Chronic Fissure of the Lip (Fr. *Perlèche*) forms in badly-nourished children who breathe through the mouth. The lip is everted, indurated, and thickened. Mercurial ointment is applied, and the fissures are also scraped, especially when there is any question of their becoming tubercular ulcers; otherwise the lymphatic glands in the neck will become affected.

Ulceration of the Lip.—Lupus extends from the face to the lips. In some old men smoking causes an eczema with crusts on the lower lip, which, when detached, expose a chronic ulcer. If the smoking is not entirely stopped, the ulcer becomes epitheliomatous.

Syphilis of the Lip.—A primary sore occurs as often on the upper lip as on the lower. It is also met with in young people, especially women and girls. It is rapid in its formation, and the induration is not circumscribed, but is continuous with the œdema of the lip. The glands below the jaw invariably enlarge at the time of the appearance of the sore; they are hard, but not of stony hardness. A roseolous rash follows, and the whole affection yields quickly to mercury.

Secondary syphilis attacks especially the angle of the mouth, and is combined with chronic superficial inflammation of the cheek, tongue, and gums.

Carbuncle of the Lip.—Carbuncle is a dangerous septic infection, but fortunately rare. It may be due to true anthrax, when the diagnosis is confirmed by the history of contact with skins, hair, and wool from animals dead of the disease, and the bacilli are found in scrapings and in blood from the indurated zone. In other cases only micrococci are found. A black slough forms in the centre, from which there rapidly spreads inflammatory induration and œdema, accompanied by fever and increasing drowsiness. If the black eschar is small and the inflammatory induration limited, the ulcer is freely scraped and rubbed with a strong antiseptic. Drops of 5 per cent. carbolic acid may be injected into different points of the indurated zone.

In more severe cases the whole carbuncle must be excised at the earliest possible moment, and the carbolic acid injected around; this is the more urgent when drowsiness or delirium is present. Anthrax or streptococcus antitoxin, according to the cause, may also be administered.

Epithelioma of the Lip.—Epithelioma occurs generally, although not exclusively, on the lower lip of old men (or women) who smoke or chew tobacco. A little eczema appears, then a scab is frequently picked off, and gradually an ulcer forms, which has an indurated border. Sublingual lymph glands begin to enlarge after an interval, and are of stony hardness. The ulcer is excised by a **V**-shaped incision, after which the lips are sutured by wire or fixed by pins. When the glands are enlarged, an incision is carried downwards from the angle of the **V**, through which they are removed. The prognosis after free removal is very good, much better than in epithelioma of the tongue.

In rare cases epithelioma of the lip appears in young patients, runs a rapid course by spreading to the neck, when the glands break down and death ensues.

Labial Cysts and Adenomata.—Small cysts arise from obstruction to the ducts of the buccal glands, and appear as a glassy vesicle containing mucus. After applying cocain, the cyst is incised and rubbed out with an antiseptic. A number of secondary vesicles sometimes form around the main one; then the mucous membrane involved is excised by curved scissors after cocainization.

Hare-lip and Cleft Palate.

Hare-lip.—When, in the course of the formation of the upper lip and alveolar process of the jaw, the maxillary process fails to unite with the nasal process, a fissure results corresponding in position to the line of separation between the intermaxillary bone and the rest of the maxilla. The fissure varies in extent from a small notch in the upper lip to a gap involving both lip and jaw, which extends into the nostril. The defect may be unilateral or bilateral. In the latter case the two intermaxillary bones may be in their normal position, or they project forwards, upwards, or are fixed to the end of the cartilaginous septum of the nose. When the hare-lip is double, it is commonly associated with cleft palate.

It is desirable to operate upon hare-lip at as early an age as possible. The operation (see Fig. 62) is commenced on the thickest side of the fissure by cutting a tongue-shaped flap from the prolabium, having its base below, so that the flap turns downwards. The thinner side of the fissure is pared of its prolabium from the apex of the fissure nearly as far out as the angle of the mouth. No skin is sacrificed on either side of the fissure. Each lip is freed from its attachment to the jaw as far out on the cheek as is necessary to got rid of all tension. This is done by cutting cicatricial tissue, and raising the rest with a raspatory or the finger. This is repeated on the opposite side when bilateral. The intermaxillary bones are pressed back into position. Sometimes this is more conveniently done a day or two before the main operation by breaking the projection partly off with blunt bone forceps. In order to bring the lip together, two silver wire sutures are passed through the lip without piercing the mucous membrane, and the sides of the cleft are then drawn together. Hare-lip pins are less convenient. The tongue-shaped flap is fixed by horsehair sutures into the angle at the lower border, for otherwise a permanent notch would be left after healing. By everting the lip, the mucous membrane is exactly united by horse-hair sutures. In order to relieve tension, the lip is pursed up and held by two hour-glass-shaped strips of strapping. The narrow piece crosses the lip, separated from the sutures by a flake of wool, whilst the broad ends must firmly adhere to the cheeks. In order to dress a hare-lip baby, the nurse and the surgeon should be seated opposite one another, the legs and lower part of the child supported by the nurse, whilst the child's head rests between the surgeon's knees. With one hand the nurse holds the child's hands; with the other she presses forwards the cheeks. In this way the surgeon has both hands free to remove sutures or to apply strapping, whilst the child cannot by crying stretch open the wound. The silver wire or hare-lip pins should be removed during the third day, lest the punctures ulcerate and leave sores. The horsehairs are left in until they are loose. The strapping is reapplied daily for a fortnight or three weeks, until firm union has taken place. The child is carefully fed with a spoon, and the mother must not put it to the breast.

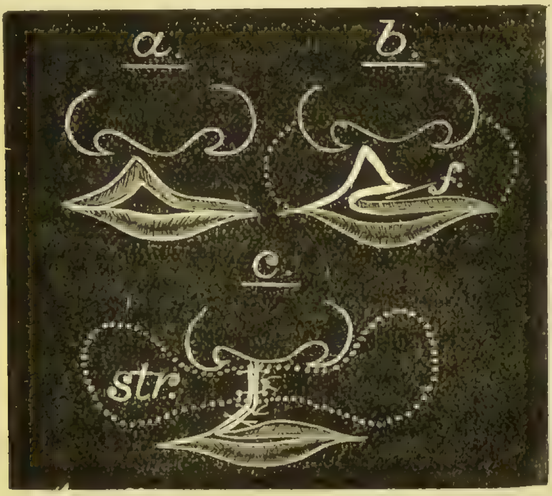


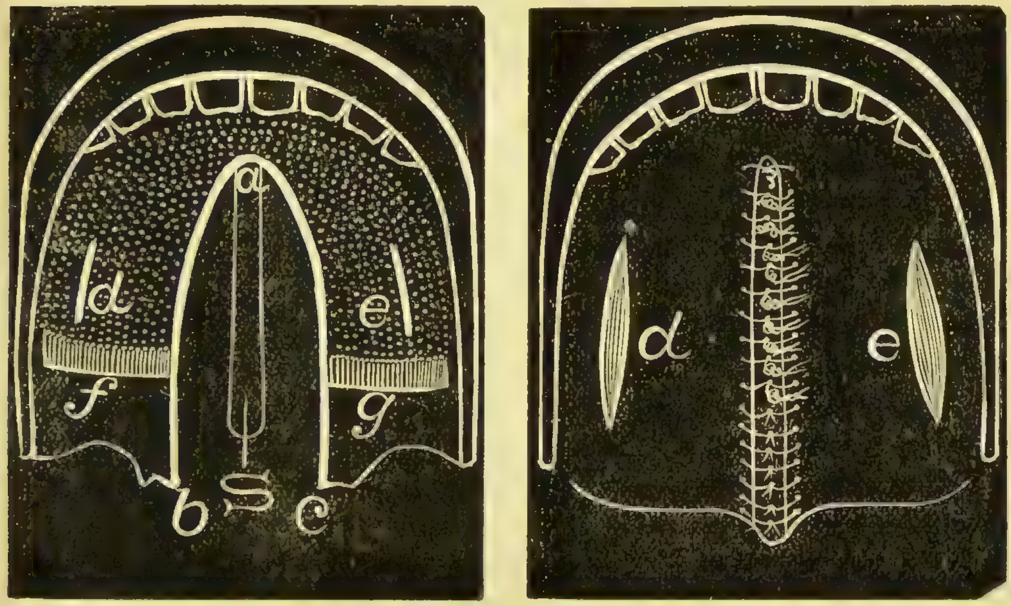
FIG. 62.—UNILATERAL HARE-LIP.

a, Cleft in lip, prolabium shaded; *b*, prolabium pared away; *f*, tongue-shaped flap, lip raised from jaw as far as the dotted lines; *c*, cleft closed by sutures; *str*, strapping.

Cleft Palate.—A deficiency in the union of the palatal processes varies in extent. There is only a bifid uvula, or a cleft of the soft palate, or the cleft includes a part of the hard palate, or the whole up to the alveolar process, the most extensive form being combined with a double hare-lip. The hard palate of one side may be attached to the septum, which is deviated accordingly.

The suture of a cleft palate is usually delayed until the child is two or three years old. If the cleft is small and the child healthy, there is no objection to the operation at a much earlier age. But in infants the muco-periosteal flaps are thin, and the sutures are apt to cut out if there is the least tension. A favourable opportunity is selected, when the child is not likely to suffer from colds, nor has lately been exposed to any infection. Thrush and spongy gums must first be treated. The fact that the child is not thriving under careful spoon-feeding is an indication for an early operation. The later the operation, the thicker, stronger, and more vascular are the muco-periosteal flaps, which permit of wide clefts being closed in. On the other hand, a defective speech is acquired, which is improved with difficulty after the suture. The teeth decay, and organisms collect in carious teeth which prevent union. The more dome-shaped the sides of the cleft, the more favourable the prospect of union. Chloroform is administered through a tube, and the head is in the hanging position. The sides of each cleft (Fig. 63, *a*, *b*) are thinly pared by long mouse-toothed forceps and knife, care being taken to complete the paring at the apex ot the cleft. The muco-periosteum is next punctured close to the alveolar border, and by inserting a curved raspatory it is raised from the bone, inwards to the cleft, forwards well beyond the anterior end of the fissure, and backwards to the soft palate. At the junction of the soft palate with the edge of the hard, there is a tough fibrous structure to be cut through by scissors. This is done by drawing forwards the soft palate, passing curved scissors behind and snipping it away from the bony edge, but taking care not to divide the soft palate from the muco-periosteum raised from the hard, nor to injure the posterior palatine artery near the hamular process. Wire sutures are inserted into the hard palate flaps by means of a hollow needle:

horsehair is used for the soft palate. The edges of the wound must be inverted towards the mouth. The wire sutures are twisted, and ¼ inch of the ends left, so as to serve as a fence against the pressure of the tongue. The punctures made for raising the muco-periosteum of the hard palate are extended backwards into the soft palate, forming two parallel incisions, which gape and relieve the tension on the sutures. After the operation, the mouth should be kept closed for a week. If the nurse is known to the child beforehand, she will be able to stop it from crying. Older patients must not talk; they should rinse the mouth out frequently with permanganate. The surgeon should not inspect the palate until a week has elapsed. The sutures are left undisturbed for six weeks, or until they threaten to fall off. If there is union of one side to the septum, the flap is cut from the septum by using a knife set into a handle at an angle of 45°.



A B

FIG. 63.—DIAGRAM OF CLEFT PALATE.

A, *a b*, *a c*, The edges of the cleft which are pared; *d e*, incisions through which the muco-periosteal flaps are raised; *f g*, the line of attachment to the hinder edge of the bone of the hard palate; *S*, septum nasi. B, Sutures inserted; *d* and *e*, extended backwards to relieve tension.

The Palliative Treatment of Cleft Palate by the Use of Obturators.—Obturators shutting off the nose from the mouth cannot be worn until growth is complete. A model is taken, upon which the obturator is shaped. Great accuracy in fit is required. If the obturator is too tight, the pressure causes atrophy and an increase of the cleft. If too loose, food gets in.

A natural obturator, preventing food from escaping from the nose, is produced by a swelling of the turbinal bones. But this perpetuates the tendency to breathe through the mouth, and induces the results of that habit.

The Mouth.

It is very important that breathing should be carried on through the nose, and that the mouth should be kept closed. Foul breath is due to the teeth, unless there is some disease causing ulceration in the course of the respiratory or alimentary tract.

Artificial Feeding.—In an unconscious patient, fluid food must be carefully passed in small quantities into the pharynx. It will be swallowed without difficulty, except when there is deep coma and the laryngeal reflexes are lost. Patients who refuse food may be fed by a tube introduced through a nostril, having a funnel attached to its outer end. The tube may be inserted through the mouth behind the molar teeth, through a chance gap in the line of the teeth, or after opening the mouth by a gag.

Stomatitis.—The stomatitis of childhood is parasitic or scorbutic. The parasite of thrush derived from stale milk forms whitish patches made up of yeast-like bodies. Thrush is prevented by boiling milk, scalding out the bottles, and washing the teats in cold water. It is treated by painting with borax and honey. Scorbutic stomatitis causes a spongy swelling of the gums, which easily bleed. The gums rise up around a tooth, and the teeth become loose and fall out. Scurvy is caused in an infant by the want of fresh milk and the use of patent foods consisting largely of starch. When seen after teething, scurvy is due to a diet too exclusively composed of bread-and-butter. Fresh milk, potatoes or other fresh vegetables, at least once a day, fruit, such as oranges, and the citrate of iron, are the means of relieving the disease. Stomatitis is produced in adults by carious teeth, by syphilis, and by tobacco. The characteristic stomatitis of edentulous people is a dry mouth, or xerostomia. There is a thick fur on the tongue, and sometimes a swelling of the parotids, owing to an obstruction to their ducts. This form of stomatitis is relieved by wearing artificial teeth.

Cancrum Oris, or Noma.—Cancrum oris is an acute phagedenic ulceration which arises in children who are weak after severe illness—especially scarlet fever. A slough forms and causes a foul smell. There is much swelling of the cheek and a fœtid discharge. The disease advances through the cheek until it destroys the skin; the patient becomes drowsy, makes no sign of pain; septic pneumonia sets in, and death follows. A most active course of treatment has to be adopted to arrest the disease. Excision and the free use of the cautery are most suitable. Pure carbolic acid, or 1 in 500 perchloride of mercury, may be rubbed in; but it is difficult to localize the application, whilst the cautery can be exactly applied.

The Teeth.

The teeth may be the better preserved by brushing regularly, aided by a tooth-powder of precipitated chalk to which carbolic acid has been added; by the removal of food from between the teeth by tooth-picks or by drawing between them a strand of floss silk; by avoiding mechanical injuries likely to chip off the enamel; and by improving the gums by astringent or alkaline mouth-washes, as well as by tonics.

Teeth may be scaled of the tartar, or if caries has extended to a limited extent, this is removed, the cavity rendered antiseptic, and filled.

Teeth in which the pulp is exposed are liable to cause an alveolar abscess, which may discharge on the cheek and form a puckered sinus; or cause a swelling of the glands in the neck, which later become tubercular, form abscesses, or set up necrosis or empyema of the antrum.

A tooth in which the pulp is widely exposed can rarely be rendered antiseptic so as to retain a filling. If an alveolar abscess or glandular swelling threatens, particularly in a tuberculous child, the carious tooth should be extracted at once. The objection that after removal of a milk-tooth the permanent tooth may not grow straight may be ignored.

If an acute inflammation of the gum or an abscess threaten, the tooth should be removed; the supposed danger of septic infection is much less than that incurred by delay.

All teeth which keep up irritation of the tongue, cheek, or gums, in men past middle life, should be removed or filed down, in order to avoid the danger of cancer.

Dislocated Teeth.—Teeth are replaced and fixed *in situ* by silk, wire or small vulcanite splints. Even if completely separated, a tooth may be replaced immediately in young people. But if the tooth has been removed for some hours, a special preparation before insertion is required.

Toothache and Neuralgia.—This may be due to a single tooth. A bit of wool less than the size of the cavity to be filled is well squeezed out of a solution of pure carbolic acid, made by adding a drop of water to the crystals, and the wool gently pressed into the cavity, or creasote may be substituted. Clove-oil is used in the same way, but more freely. Glycerin, chloroform, and pure carbolic acid (equal parts) may be mixed, and one-tenth part of morphine hydrochlorate added, and the wool soaked in it. If due to acidity, a mouthwash, consisting of a saturated solution of bicarbonate of soda, is given.

Painting the gums with a 4 per cent. solution of cocain relieves tender and painful gums. Menthol (10 per cent.) in parolein solution may be also employed.

If a gum-boil or alveolar abscess threatens, an early incision is made, followed by hot-water fomentations.

Toothache or neuralgia may be due to a cold, and be relieved by phenacetin or quinine in full doses, aided by a purge, and linimentum aconiti externally.

Neuralgia may be due to anæmia, malaria, syphilis, etc., and yield to iron, quinine, or mercurial treatment, according to the cause.

In older patients the pain may be caused by neuritis in some or all of the branches of the fifth nerve, and not be relieved except by surgical treatment of the root of the fifth nerve or its branches.

Extraction of Teeth.—The extraction of a tooth may be done with either hand, the surgeon standing in front or to the side of the patient. The other hand firmly supports the jaw to prevent dislocation, and at the same time presses the tongue aside. The forceps are held sufficiently wide apart by inserting the ball of the thumb between the handles. The blades are applied on the lingual and buccal side respectively, and pushed down well over the crown without including any of the gum; then, without stopping, lateral movements are made, and the tooth pulled away as quickly as possible. The upper incisors, canines, and lower bicuspids are rotated on their axis as well as moved laterally.

Stumps and roots are extracted by forceps whose blades meet, the blades being pushed down far enough to grasp the fang, or an elevator may be inserted between the alveolus and the stump, so as to lever it out. Whilst the elevator is suitable for the lower molars, its use is dangerous in the case of the upper ones, for the upper jaw and antrum may be injured.

Extraction of Teeth under Anæsthesia.—Nitrous oxide gas is the one anæsthetic. Local anæsthetics, such as cocain or chloride of ethyl, are either ineffectual in relieving pain or, if freely used, dangerous. If a little air be given as the patient becomes blue, and then some more gas, the anæsthesia is prolonged. Up to five minutes the patient is kept under by a little ether in addition. Oxygen may be combined with the nitrous oxide, but the administration must not last longer than the time occupied in extracting about three teeth, or nausea and sickness may ensue. Chloroform ought never to be administered except in a recumbent posture. If a number of teeth have to be removed at once, and chloroform is given, the case should be treated as a serious surgical operation, and the usual precautions taken. The patient is kept without food beforehand, and remains in bed for a day or more after.

Before commencing the anæsthesia, a prop is inserted on the opposite side to the proposed extraction, so that the gag can be applied without delay. Each tooth as it is extracted must be carefully brought out, and the finger retracting the tongue must guard against it slipping into the pharynx. A tag of gum may be cut away with scissors.

No great force should be employed; a tooth which has been wrenched will be found looser in a week's time. If a root cannot easily be got at, it may be left for a few weeks, when it will project, and can then be more easily removed.

Recurrent hæmorrhage is avoided by not biting on the gum for a day or two. If it occurs, the patient closes the jaw on a pad placed on the bleeding-spot, and a child's jaw is fixed by a chin bandage.

If necessary, the alveolus is plugged with gauze. Only very rarely should perchloride of iron be employed; it is best used by soaking strips of lint in the liquor ferri perchloridi, and then drying them. The only real danger is in a case of hæmophilia. Bleeders, also those whose jaw has been dislocated, ought always to mention their liability when consulting a fresh practitioner before any measures are taken.

A tumour of the gum, or epulis, is freely removed with the tooth.

Tumours of the teeth, or odontomes, are rare and usually small; they are removed with the teeth to which they are attached.

The Salivary Glands.

Acute Inflammation of the submaxillary and sublingual salivary glands occurs exceptionally in mumps. Subsequent to this the gland remains tender and indurated for a time.

Suppuration, the formation of an abscess and of a fistula, are due to calculi.

Salivary Calculi.—A salivary calculus is a concretion consisting of carbonates, which, when single, forms in Wharton's duct, from which it takes an almond shape. There is much pain and tenderness, and, if not removed, abscesses and fistulæ result. The duct is incised under cocain or under nitrous oxide gas, and the calculus extracted by forceps.

Multiple calculi are also met with. They are small calculi, about the size of pearl-barley, arising in the secondary ducts from mucus concretions. They give rise to intermittent swellings, followed by the discharge of pus through the main duct.

The main duct is slit up, and the calculi scooped out. Eventually the gland may have to be excised, the facial artery being ligatured on both the proximal and the distal side.

Cysts or Ranulæ arise by obstruction of Wharton's duct, or of the sublingual duct, or of the duct of one of the small glands beneath the tip of the tongue. It is recognised by its thin bluish wall containing inspissated mucus. As much as possible of the cyst wall is cut away under cocain, and the interior of the cyst is wiped out with a strong antiseptic or caustic so as to destroy it. The cyst invariably refills if only a small puncture is made. If a general anæsthetic is given, the whole cyst should be cleanly dissected out.

Tumour.—The submaxillary gland may be affected by carcinoma. Before operation the disease is likely to be attributed to the submaxillary lymph glands, and the carcinomatous character only discovered by microscopic examination of the tumour.

The Tongue.

Hypertrophy of the Tongue is caused by a congenital dilatation of the lymphatics of the tongue, which form cysts, separated from one another by inflammatory fibrous tissue. The tongue fills the mouth and impedes respiration and speech. As it continues to enlarge, the tongue protrudes from the mouth and depresses the teeth of the lower jaw. The edges of the teeth set up ulceration, and repeated hæmorrhages take place from the ranine veins and arteries. By cutting away a portion the tongue is reduced to a moderate size.

Atrophy of the Tongue.—Paralysis and atrophy is caused by division of the hypoglossal nerve through a wound in the neck, also when it is involved by atlo-axioid disease, or by an aneurysm on the vertebral arteries. These conditions must be distinguished from bulbar palsy.

Defects of Speech, as far as they are mechanical in origin, arise from cicatricial fixation of the tongue following ulceration, and also from irregularities in connection with the teeth.

Tongue - Tie. — There is no such thing as congenital tongue-tie. The tip of the tongue at birth projects but a little way beyond the fræenum, so that the frænum seems to be prominent; but it soon grows in length, and the baby can protrude it beyond the gums. It is an erroneous popular notion that the apparent prominence of the frænum indicates a congenital tongue-tie. It is a young mother with her first baby who is likely to be anxious on the matter. There is no indication for the division of the frænum, and it is quite wrong to do it. A septic ulcer is caused, which may occasion suppuration in the neck, repeated hæmorrhages from the ranine vessels, and death from choking owing to the tongue being 'swallowed'; *i.e.*, the tip is turned back and impacted in the fauces.

Such an operation is, moreover, quite useless, for after healing the tip will be more fixed than before, according to the amount of ulceration and scarring which has been set up.

Injuries to the Tongue.—The tongue is bitten during epileptic fits, and the wound should be at once sutured with horsehair. Wounds penetrating the mouth, or due to bullets, may pierce the lingual artery. The vessel must be tied either in the mouth or through the neck.

Acute Glossitis is an extension of septic inflammation from the teeth and jaw. A most dangerous and rapid œdematous swelling may be caused by a wasp-sting. The swelling of the tongue is relieved by free incisions of the dorsum. An abscess beneath the tongue is drained through an incision in the middle line below the chin. When the septic œdema spreads to the neck, it produces the condition called Ludwig's angina. Early exploratory incisions must be made in search of pus, avoiding the course of the blood-vessels; in addition, antistreptococcic serum is administered. There is great danger of the extension of the septic œdema, and suppuration to the mediastinum, pericardium, pleura, and lungs.

Chronic Superficial Glossitis.—A chronic superficial inflammation of the tongue is generally syphilitic in origin, carious teeth, tobacco, hot spices, and alcohol adding to it; but the latter causes may originate the disease apart from any syphilitic taint. The first change is a heaping up of the epidermis, producing whitish patches, giving rise to the terms icthyosis or psoriasis of the tongue. The thickened layers of epidermis fall off along with the papillæ of the dermis, leaving a smooth scar-like surface resembling that caused by a burn. This surface remains tender, painful, and is easily irritated. If ulceration supervenes upon this scarred condition, and healing does not follow the administration of antisyphilitic remedies, a diagnosis of epithelioma can be with certainty made.

All sources of irritation must be avoided or removed. Chromic acid in 10 per cent. solution is painted on the tongue twice a day after drying the surface. If this fails to relieve, 1 in 1,000 mercuric chloride or cyanide is carefully painted on by the surgeon. The application of the latter remedies can only be entrusted to a careful patient, on account of their poisonous nature.

Primary Syphilitic Sore on the Tongue.—Chancre of the tongue causes a rapid swelling, forming an indurated mass, accompanied by an enlargement of the submaxillary glands, intermediate in hardness between inflammation and cancer. It is distinguished from inflammation by the absence of redness, heat, and pain; from cancer by the rapidity of development. The diagnosis is confirmed by the invariable appearance of a roseolous rash on the trunk, and by the rapid subsidence of the swelling under the administration of mercury.

Ulceration of the Tongue.—Secondary syphilitic ulcers occur on the sides of the tongue, and may be multiple. Gummatous ulcers form in the median raphe, and are single. Ulceration caused by a jagged tooth is situated on the part of the tongue which comes in contact with the tooth.

If an ulcer of the tongue is indurated, and shows no signs of healing, the question of the disease being epithelioma comes up for consideration. If secondary syphilis is suspected, the administration of mercury is pushed, especially by means of inunction, until there are signs of stomatitis. For tertiary syphilis iodide of potassium is given in doses increasing in amount even to a drachm, during which the patient should keep his bed. It is best to push anti-syphilitic remedies to the full dose, so that the diagnosis of syphilis may be confirmed or not within a week or ten days.

Tubercular ulceration of the tongue is met with on the tip or dorsum of the tongue in the later stages of pulmonary phthisis. It is also seen as an extension from lupus of the face. Primary tubercular ulceration is a very rare disease. The ulcer may be cocainized, curetted, and then rubbed with lactic acid.

Carcinoma (Epithelioma) of the Tongue.—Squamous-celled carcinoma is the common type of malignant disease; sarcoma of the tongue is very rare. It generally commences in some simple form of ulcer, such as is caused by syphilis or carious teeth. Tobacco acts by aggravating the ulcer, or when the tongue is constantly irritated by a pipe stem, an ulcer is produced by smoking alone. Instead of tobacco, hot spices may continually irritate an ulcer. A family history of cancer is not necessary, but the cancer then occurs earlier, and is more virulent. The signs of epithelioma are a progressive ulceration and an increasing induration and eversion of the margin of the ulcer. There is very soon some tenderness of the glands, and this is followed by enlargement. There is an increased formation of saliva, and neuralgic pains become greater, and are referred to other branches of the fifth nerve.

There is only one treatment for cancer of the tongue, viz., excision of the tongue from the mouth, partial or complete. When the ulceration commences on the dorsum of the tongue, and has not invaded the floor of the mouth nor the glands, the tip may be cut off, wedge-shaped notches excised, and the edges of the V-like gap brought together. The half of the tongue may be excised, or if all the dorsum is diseased, the whole of the tongue may be removed.

The mouth is held open by a gag, the tongue is examined with the finger, and a decision is made as to the extent of the growth. When the disease involves only one side, a silk ligature is passed through the tip of the tongue on each side, and the tongue drawn out of the mouth. The tip of the tongue is split along the middle line, at first by cutting, further back by simple tearing down the middle line with the fingers. The mucous membrane of the floor of the mouth is cut away from the lower jaw, extending from the frænum backwards as far as the disease reaches. The half of the tongue is cut across behind this by short snips with scissors. The dorsalis linguæ artery is divided at the upper and outer angle of the vertical section (Fig. 65), and requires to be clamped. The lingual artery runs beneath the main muscle of the tongue, and near the middle line (Fig. 64). The ranine vein is seen on holding up the tongue, and the ranine artery lies just beneath it in a fibrous sheath, accompanied by the lingual nerve. The lingual artery can be generally seen and clamped before it is cut across. If the artery is cut across before being clamped, blood may spurt up against the upper teeth, and so regurgitate into the pharynx. If the tongue is so drawn upon that the artery

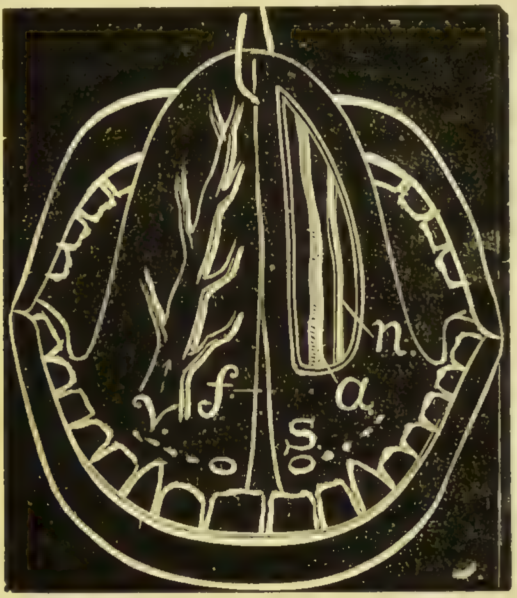


FIG. 64.—COURSE OF THE VESSELS IN THE FRONT OF THE TONGUE.

v, Ranine vein immediately beneath the mucous membrane; *a*, ranine artery; *n*, lingual nerve, exposed by removing the mucous membrane and the vein; *f*, frænum; *s*, submaxillary duct.

spurts out of the mouth, no great harm is done, and the spouting artery can be seized by a clamp. In order to compress and control the lingual artery, the finger is passed down the pharynx as far as the epiglottis, and then hooked upwards on the inner side of the angle of the jaw.

In order to make a complete section of the tongue, one ligature is passed through the lip, and another through the tongue behind the disease, so that the stump may be drawn upon at any time. The frænum is cut away at its attachment to the jaw, the mucous membrane divided on either side, and then the tongue is drawn well out of the mouth. By small cuts the whole section is made, great care being exercised to clamp and tie the linguals before they are injured (Fig. 65). The ligature passed through the stump is allowed to remain for a day, the ends being knotted and fixed on the cheek by a strip of strapping. The stump can thus be drawn forwards if there is any difficulty during recovery from the anæsthesia or from recurrent hæmorrhage.

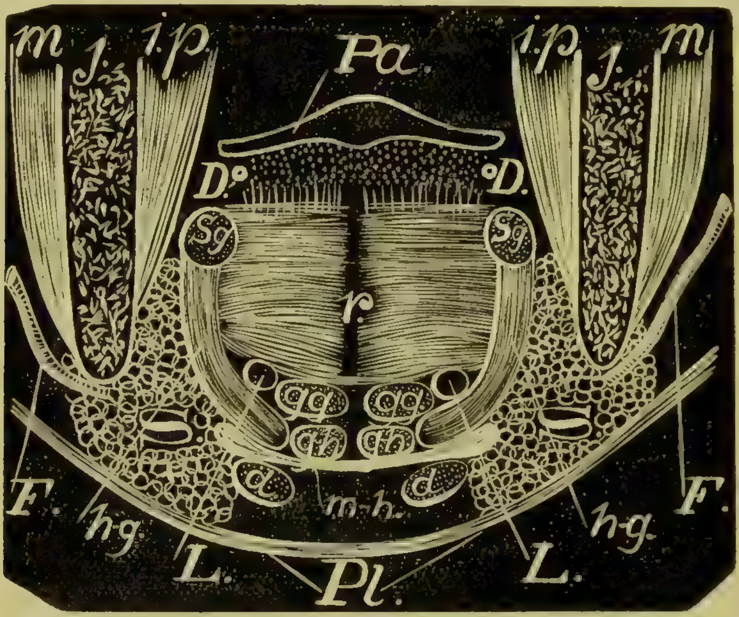


FIG. 65.—LINGUAL ARTERIES IN A TRANSVERSE SECTION OF THE TONGUE AT THE HINDER BORDER OF THE MYLO-HYOID MUSCLE.

Pa, Soft palate; *m*, masseter; *j*, lower jaw; *i p*, internal pterygoid; *Sg*, stylo-glossus; *hg*, hyoglossus; *r*, raphe in the lingualis muscle; *gg*, genio-hyo-glossus; *gh*, genio-hyoid; *mh*, mylo-hyoid; *d*, digastric; *Pl*, platysma; *S*, submaxillary gland; *L*, lingual artery; *D*, dorsalis linguæ artery; *F*, facial artery.

Submaxillary Removal of the Tongue.—When the ulcer involves the floor of the mouth, when the glands are already tender or enlarged, or when, the ulcer having developed in the side of the tongue, an involvement of the glands may be reasonably suspected, the tongue and the enlarged glands with the intervening lymphatics must be excised in one mass through an incision below the jaw (Fig. 66). The head being extended and turned to the opposite side, an incision is made from the chin vertically downwards to the hyoid bone, horizontally along the bone to the great cornu, and upwards to the angle of the jaw. The skin is raised as far as the line of the jaw, the platysma and the deep fascia are divided, and several large veins clamped. The submaxillary salivary and lymphatic glands are hooked upwards, and the digastric triangle defined, as well as the hypoglossal nerve. In the triangle made by the tendon of the digastric and the hypoglossal nerve are the fibres of the hyoglossus muscle, which are separated by anatomy forceps held in each hand. The lingual artery so exposed is clamped on the distal side, ligatured on the proximal side, and then cut across between

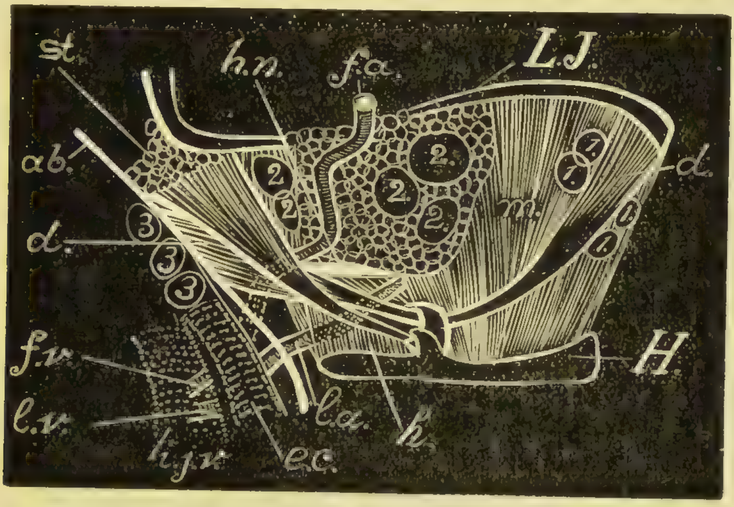


FIG. 66.—DIAGRAM OF SUBMAXILLARY TRIANGLE.

L J, Lower jaw; *H*, hyoid bone; *a b*, anterior border of the sterno-mastoid muscle; *d*, *d*, digastric muscle; *st*, stylo-hyoid muscle; *h*, hyoglossus muscle; *m*, mylo-hyoid muscle; *e c*, external carotid; *i j v*, internal jugular vein; *h n*, hypoglossal nerve; *l a*, lingual artery; *f a*, facial artery; *l v*, end of lingual vein; *f v*, end of facial vein; 1, 1, sublingual lymphatic glands; 2, 2, submaxillary lymphatic glands; 3, 3, sterno-mastoid or carotid lymphatic glands.

the ligature and the clamp. If more convenient, the lingual artery may be tied before passing under the hyoglossus, as it runs just above the great cornu of the hyoid, for which purpose the posterior belly of the digastric can be cut across.

By hooking up the submaxillary gland, the tortuous facial artery is straightened out, and stretches from the anterior border of the sterno-mastoid and of the digastric muscles to the gland, and a ligature is easily put upon it. The submaxillary gland being turned down, the facial artery is found at the base of the skin flap, on the outer surface of the lower jaw. The distal end of both facial artery and vein must be tied.

At the upper angle of the wound the sterno-mastoid must be retracted so that glands may be removed. Just behind the angle of the jaw enlarged lymphatic glands may be continuous with the lower edge of the parotid. The external carotid is just beneath these structures.

In the first part of this operation, therefore, the furthest extent of the operation is defined, and the bloodvessels ligatured. This must be carried out on both sides if the whole tongue is taken away. The next step is to separate the genio-hyoid, genio-hyoglossus, and the mylo-hyoid from the lower jaw by means of a knife, working through the submaxillary wound, and keeping the edge close to the inner surface of the jaw. The tongue is then drawn out beneath the jaw into the submaxillary wound. If only one half is affected, the tongue is split down the middle, and the affected half cut away. If the whole of the tongue is diseased, it is cut across transversely well behind the cancer, if necessary close to the hyoid bone. Before doing so, a ligature is passed either through the stump or through the epiglottis. No spouting bloodvessel is met with after tying the lingual and facial.

Extensions of the foregoing operation may be required. A piece of the jaw may be involved. It is excised by cutting across with strong bone forceps, and the cut ends should be fixed apart by a bar, so that a denture may be later on fitted and deformity avoided. The tonsil pillars of the fauces and soft palate can be cut away whilst the head is hanging low. If enlarged glands are felt along the carotid sheath, the sterno-mastoid is retracted and the glands carefully dissected off the carotid artery and jugular vein. A piece of the jugular vein or external carotid artery may be excised if involved, but the common carotid artery and the internal carotid, as well as the vagus nerve, should be left untouched. Iodoform, especially the largest crystals, is spread over the wounded surface with the finger, and a plug of iodoform gauze may be pressed in, the ends of the strip coming out of the mouth. The wound in the neck is then sutured ; a strip of gauze or a short tube is placed in the most dependent angle. Permanganate wash and iodoform insufflations are used every three hours ; the patient lies on his side with the head low, so that all saliva and discharge runs out of the mouth. He should get up as soon as possible after the first day. The main danger in an advanced case is from the weakness of the patient due to semi-starvation. Rectal feeding may be required for a few days. Liquid food may be given by attaching a rubber tube to the spout of a feeder, and pouring the fluid into the pharynx behind the stump ; or feeding may be done through the nose and œsophagus. Later on finely divided food is rolled into balls the size of marbles, greased with butter, and placed within the grasp of the fauces by a spoon or fork on a long shank.

Palliative Treatment of Cancer of the Tongue.—The removal of a foul mass from the mouth may relieve although the disease continues in the neck. Hæmorrhage from the growth may be stopped by ligaturing the linguals without removal of the tongue.

Pain is relieved by the free administration of opium and morphine, and by resecting the lingual nerve if the disease involves it. The removal of the teeth and frequent permanganate mouth-washes diminish the foul discharges, and so the pain and the liability to septic pneumonia.

The Hard Palate.

Periostitis and abscess are caused by carious teeth.

Syphilis causes gummata, which ulcerate, set up necrosis, and so the palate is perforated or largely destroyed.

Tumours of the hard palate are generally median. They are cysts, adenomata or mixed-celled sarcomas. The tumours shell out easily, and this is done with the head hanging low. The prognosis after removal is good.

The Soft Palate and Uvula.

Ulceration and perforation or destruction is caused by syphilis. An adhesion between the ulcerating soft palate and the back of the naso-pharynx ensues, so that the nose is partially or completely shut off.

Adhesions are prevented by stretching the soft palate with a hook after cocainization. When there are firm adhesions separation under anæsthesia is indicated in order to restore nose-breathing and to relieve Eustachian obstruction. The more scar tissue there is in the soft palate, the more unfavourable is the result of this separation.

Epithelioma of the soft palate is often an extension of the disease from the tongue or tonsil. When primary, the prognosis is not good on account of early involvement of glands.

Long Uvula.—When the uvula is excessive in length it may cause pharyngeal irritation and cough. But less importance is now attached to the uvula and its hypertrophy than formerly.

The uvula is removed by the galvano-cautery snare or by scissors. There is a good deal of pain and discomfort set up, and the singing voice may be affected. The uvula therefore should never be removed unless there is good cause for supposing that it is the origin of the pharyngeal trouble.

CHAPTER XXIII.

SURGERY OF THE TONSIL, PHARYNX, AND ŒSOPHAGUS.

The Tonsil.

Acute Tonsillitis is a catarrhal disease, in adults allied with rheumatism. The rapid swelling of the tonsils is accompanied by lassitude and fever, the temperature rising to 103° F. or more. There is difficulty in breathing when the tonsils meet in the middle line, there is also dysphagia, the saliva is ropy and cannot be swallowed without great pain. After a purge the patient is given full doses of quinine or salicylate of soda. Hot fomentations are applied to the neck, the tonsils are painted with a 20 per cent. solution of cocain, and ice is given to suck. Gargles cannot be used in the acute stage of tonsillitis.

Tonsillar Abscess.—An abscess is indicated by the special enlargement of one tonsil, which, after painting with cocain, may be touched to see whether there is fluctuation. If an abscess threatens, the swelling is punctured in several places. If an abscess is found, it is opened by a horizontal incision. The edge of the blade is directed inwards, and is guarded nearly up to the point to avoid cutting the angle of the mouth. A curved pointed bistoury is prepared by winding a strip of strapping round the blade nearly up to the point.

Scarlatinal Tonsillitis is indicated by the bright redness of the palate and fauces, the existence of a rash, and later on the signs of desquamation, accompanied in some cases by slight albuminuria. The diagnosis is confirmed by evidence of contact with a scarlet fever case.

Diphtheritic Tonsillitis is shown by whitish patches of membrane adherent to the tonsil, so that it is not easily detached. The fauces and soft palate have a dusky-red appearance. In the neck the corresponding lymphatic glands are swollen and hard. The diagnosis is completed by finding diphtheria bacilli in the membrane.

Antitoxin is administered in all except very late cases. The membrane should be wiped off, after which the spots are carefully rubbed with a pledget of cotton-wool soaked in 5 per cent. solution of carbolic acid or 1 in 1,000 perchloride of mercury. This operation is repeated every hour or two for the first day or so. The surgeon and nurse must guard against expectoration reaching their mouth or eyes. If the membrane is firmly adherent, it is painted over with papain and lactic acid (papain gr. ii., lactic acid gr. ii., freshly mixed in ʒss. of water). By this paint the membrane is digested so that it can be scraped off.

Follicular Tonsillitis.—The crypts of the tonsils become distended by whitish concretions composed of pus and organisms. Tonsils so affected are the seat of recurrent inflammation until the concretions are removed. If the tonsils project, the simplest way is to shave off the projecting portion with the tonsillotome. If the tonsils are not enlarged, the surface is cocainized and the crypts curetted, or cauterized by inserting a red-hot point into the cavity and moving it about. The cavities may also be wiped out with a strong antiseptic. Bridges of tissue uniting two adjacent crypts may be torn through.

Hypertrophy of the Tonsil.—Repeated inflammations of the tonsils following attacks of scarlet fever, measles, or catarrh cause the tonsils to enlarge, with difficulty in breathing at night, and dysphagia. The child remains in weak health, subject to colds, whilst its intellect is dull. Adenoids often accompany hypertrophy of the tonsil, and in the slighter cases, if the tonsils are excised and breathing through the nose practised, the adenoids may disappear.

Partial Excision of the Tonsil, or Tonsillotomy.—The partial removal of an enlarged tonsil is done during the chronic stage of inflammation, and it is quite the exception for acutely inflamed tonsils to be removed. Still, this may have to be done to obviate respiratory obstruction. There is a little more hæmorrhage than is usual where the disease is chronic.

Tonsils are removed from a child by the spade guillotine. The child is seated on a chair or in the lap of a nurse, whilst the hands and head are made steady. The guillotine is slipped into the mouth on the flat, pushed backwards, and, guided by the finger of the opposite hand, the ring of the guillotine is slipped over the tonsil. Then firm counter-pressure is made by the finger of the surgeon or of his assistant, so that the tonsil does not slip when the cutting blade is driven forwards. The knife must be pushed sharply home so as to cut through the tonsil, and the portion cut off is hooked out of the mouth by the finger, so as to prevent it from being swallowed. The guillotine acts as a gag, and prevents the finger from being bitten. A general anæsthetic is unnecessary. Cocain may be painted on the tonsils of adults, but it is not of much service. The patient is given soft food for a few days; adults may take lozenges, pastilles of cocain and rhatany, or some other astringent, or may use permanganate or chlorate of potash gargles.

Hæmorrhage is very rare if only the projecting part of the tonsil be cut off. If oozing continues, the patient should suck ice, or pressure may be made with a sponge in a holder or by a stick having lint surrounding its end. The lint may be dipped in perchloride of iron, or the stump may be cauterized.

Simple Ulcers of the Tonsil.—The kidney-shaped ulcer on the tonsil is symmetrical and accompanies the secondary rash of syphilis.

Tubercular ulcers of the tonsil are rare, and generally are secondary to pulmonary disease. A scraping may be examined for tubercle bacilli. The tonsils should be painted with cocain, curetted and cauterized, or painted with lactic acid.

Epitheliomatous Ulcers.—An epitheliomatous ulcer on the surface of a tonsil has been successfully removed by the guillotine. Removal of deep ulcers has been done through an incision in the neck, but the operation is dangerous from the disturbance of the internal carotid artery, and is likely to be unsuccessful owing to the early infiltration of the deep glands. The after-treatment is much the same as for disease of the tongue.

Lympho-Sarcoma.—A rapid overgrowth of the tonsil occurs in a patient beyond middle age, which at first looks like a simple hypertrophy. It is well encapsuled, and can be shelled out after division of the capsule, which may be done with the cautery to avoid bleeding. Enlarged glands may also be removed through a skin incision. A favourable issue may be anticipated.

The Pharynx.

Foreign Bodies.—Pieces of meat or other articles of food may lodge in the pharynx and cause choking, unless quickly removed by the finger, aided, for instance, by a fork.

Injuries.—The pharynx may be injured from the neck—*e.g.*, in a suicidal attempt. It may be injured internally by corrosive poisons thrown into the lower pharynx. The spinal cord may be injured through the posterior wall, and the internal carotid and the vagus nerve through a wound at the side.

Ulceration.—Traumatic ulceration may be due to corrosive poisoning and lead on to stricture. Stricture may also result from syphilis, and occasionally from chronic tuberculosis or lupus. Usually a tubercular ulcer is secondary to pulmonary tuberculosis.

Stricture.—It may be prevented by the passage of bougies during the healing of the ulceration. The stricture may be carefully nicked anteriorly or posteriorly, and then dilated with bougies, the incisions being guided by the mirror or finger. If dilatation is unsuccessful, gastrostomy is indicated.

Post-Pharyngeal Abscess.—This may arise from tuberculosis of the vertebræ, from suppuration in a prevertebral gland, by direct extension from the pharynx through a suppurating follicle, or follow upon a perforating wound of the posterior wall. Sudden death may be caused by the bursting of the abscess.

The abscess is opened from within by an incision in the middle line with the hanging head. If large, it is best to open the abscess from the neck by making an incision behind the sterno-mastoid and thrusting forceps forwards behind the vessels and nerves.

Pharyngeal Tumours.—A cyst or fibrous tumour occasionally forms in the wall, and as it grows sinks downwards, so that it comes to hang by a pedicle. It may be removed by a galvano-cautery snare with the head hanging low.

Malignant Disease of the Pharynx has been removed through an incision in the neck. But the operation is a dangerous one, owing to the internal carotid being exposed, and is likely to fail in affording relief owing to the prevertebral glands being involved.

Subhyoid Pharyngotomy (see Fig. 70, p. 265) has been done for the removal of foreign bodies and tumours by a transverse incision across the middle line just below the hyoid bone.

Lateral Pharyngotomy (see Fig. 70, p. 265) affords more room for the removal of tumours. The hanging head or a preliminary tracheotomy is necessary. An oblique incision is made between the cornu of the hyoid bone and the ala of the thyroid cartilage. The sterno-mastoid and the carotid sheath, with its contents, are hooked outwards, and the superior thyroid and other bleeding vessels tied before the mucous membrane is cut into.

The Œsophagus.

The œsophagus is examined by a sound soft enough to bend when the end reaches the back-wall of the pharynx, but not so soft as to double up. An ivory-tipped bougie gives out a sound when it strikes a hard foreign body. An expanding horsehair probang is used for the extraction of foreign bodies. Auscultation may throw light upon the passage of liquids into the stomach.

A large-sized rubber catheter may be passed into the stomach, and a funnel attached at the outer end. Through this the patient may be fed with liquid food, or the stomach washed out with water.

Dysphagia.—Difficulty in swallowing may be functional in origin, due to spasm, or simply to inhibition of peristaltic action. It is generally seen in women, often following the scraping of the œsophagus by a bone. The passage of an œsophageal bougie shows that there is no obstruction, and this may convince the patient that her fears are imaginary. Difficulty in swallowing owing to paralysis of the muscle wall occurs in the course of progressive bulbar palsy. In other cases dysphagia is the result of an organic lesion, the impaction of a foreign body, ulceration, internal stricture, or external compression.

Foreign Bodies in the Œsophagus.—A coin held in the mouth may be accidentally swallowed; a loose tooth-plate may be swallowed during sleep. The object may be struck by an ivory-tipped probang, and may be removed by the expanding probang or coin-catcher, or be pushed into the stomach. Sometimes the plate can be felt from the neck just below the cricoid cartilage. Its position may also be defined by the X-rays. Attempts at extraction or pushing onwards become more dangerous after a day's interval, owing to the ulceration, and therefore the greater liability to perforation. Occasionally the object has been returned by spontaneous vomiting. Failing in attempts at removal from within, œsophagotomy is indicated, or gastrotomy if the impaction is at the cardiac orifice.

Œsophagotomy (see Fig. 67, p. 257).—The level of the impaction may be indicated by the probang, or by examination of the neck before or after incision. An incision is made between the sterno-mastoid and the bloodvessels on the left side. The former is retracted outwards and the latter inwards. The œsophagus is incised longitudinally, and after the removal of the foreign body is exactly sutured, but the rest of the wound is filled with gauze. Several fatal cases have occurred after union of the external wound as well as that of the œsophagus, owing to deep-seated suppuration of a virulent type, perhaps arising from germs carried down by the tooth-plate.

If the foreign body be lodged within the thorax, attempts should be made to reach it, otherwise ulceration and perforation into a large vessel, or into a bronchus, pericardium, or posterior mediastinum, will inevitably ensue. It may be possible to reach it from the neck, or from within the stomach after gastrostomy, or by cutting through the necks of the ribs into the posterior mediastinum.

Hæmorrhage from the Œsophagus.—Blood may be regurgitated from the œsophagus owing to ulceration, whether from a foreign body or from malignant disease; also from the leakage of an aneurysm, from varicose veins, etc. The absence of an acid reaction distinguishes œsophageal from gastric hæmorrhage. Rupture has followed vomiting.

Stricture of the Œsophagus.—Multiple strictures may be traumatic in origin, from corrosive poisoning or from foreign bodies. Ulceration following syphilis or small-pox has also caused it. It should be prevented from becoming too tight by early dilatation with bougies. If it becomes impermeable, gastrostomy may be required. After gastrostomy, it may be again possible to pass a bougie when the œsophagus has undergone a rest from swallowing. In several cases a bougie has passed upwards from the stomach through a stricture impermeable from above, for when the bougie was passed from above it entered a diverticulum.

Single strictures are generally annular. They may be congenital in origin, appearing in children. More often they are malignant.

Malignant Disease of the Œsophagus.—It is generally epitheliomatous, starting from the mucous membrane, but a sarcoma may grow in the wall. It may at first form a tight stricture, with a dilatation of the œsophagus above, and be indicated by dysphagia, especially for liquids, and by regurgitation of food. This is easily diagnosed by the resistance met on passing a large-sized bougie. On the other hand, the disease may chiefly form an ulcer, extending widely without presenting an obstruction to the passage of a bougie. Its presence may be suspected from pain in swallowing, cough, and vomiting from vagus irritation, with the hawking up of foul mucus and blood. Meanwhile emaciation results from want of food. Septic complications lead to an abscess in the mediastinum, or perforation into a bronchus, and septic pneumonia, or the communication with a large vessel is followed by death from hæmorrhage. Secondary growths occur in the liver and lung if the patient survives long enough.

Treatment of Œsophageal Cancer.—An excision of the growth with union of the cut ends has been done from the neck. But palliative measures are practically the only ones available. Judicious feeding and the careful passage of a bougie may relieve for a time. A catheter may be passed and tied in, with the end out of the mouth, through which the patient is fed, or Symonds' funnel-shaped tube may be passed through the stricture up to the neck of the funnel. Natural deglutition will take place, provided that the upper end of the funnel is below the level of the larynx. No harm will ensue if the funnel slips into the stomach. Meanwhile, rectal feeding is also used, according to the patient's wants. If these measures fail, gastrostomy is done. In early cases, where the œsophagus becomes tightly strictured, and before emaciation has become marked, life may be prolonged by gastrostomy for nearly a year. In advanced cases no relief is afforded by this operation.

Œsophageal Pouch.—A pouch is indicated by a swelling in the neck after deglutition, which on being compressed causes food to be regurgitated. It may occur independently of a stricture. Excision with suture of the œsophagus from the neck has been successful.

CHAPTER XXIV.

SURGERY OF THE LARYNX.

Examination of the Larynx.

THE larynx may be examined by palpation of the outside through the skin. The contractions of the crico-thyroids, and the vibration of the vocal cords during vocalization, may be felt. Alterations in the shape, the covering of points of the cartilaginous tissue by inflammation or new growth, and the enlargement of lymphatic glands, may be perceived. A digital examination of the opening in the glottis can be made in children when under chloroform, and to a less extent in adults under cocain.

The ordinary way of examining the larynx is the indirect method. A mirror is held against the soft palate and illuminated from the front. The image is reversed as far as regards the antero-posterior direction, but the sides of the image correspond with the object. One difficulty which is inherent to the indirect method is that the image affords, strictly speaking, information only as to two dimensions—length and breadth; the idea of depth has to be formed from experience, and an accurate knowledge of the naked-eye appearance of the larynx when viewed directly from above. Two difficulties are met with whilst using the laryngoscope—irritability, causing spasmodic or rhythmic swallowing movement, which can be relieved by painting the soft palate and pharynx with a 20 per cent. solution of cocain ; and a overhanging epiglottis, which can be hooked forwards by a specially-made tongue-depressor.

The indirect examination of the larynx can be carried out in children by partly chloroforming the child, and then painting with cocain. The larynx may be examined directly in some children and adults suitably formed. The head hangs over the end of the table, and a speculum or retractors are introduced to press forwards the tongue.

Foreign Bodies in the Respiratory Tract.

A foreign body entering the larynx may cause sudden death from asphyxia. If the obstruction is partial, there is at first dyspnœa, then chronic laryngitis, with impairment of voice. If the dyspnœa is slight, and a view can be obtained after cocainization, the foreign body may be seen and extracted by laryngeal forceps. If there is much dyspnœa, tracheotomy is done at once, and a sponge pushed upwards so as to drive the foreign body into the pharynx. The head should be hanging low, or the body will be lost by slipping into the œsophagus.

An object such as a pea or orange-pip may slip through the larynx into the trachea, where it moves up and down, causing stridor, alternating with spasm as the body approaches the larynx. Tracheotomy is required forthwith. Foreign bodies lodge as often in one bronchus as the other, for although the right has rather the larger orifice, the left is a more direct continuation of the trachea. The sign of the impaction of a foreign body in a bronchus is the complete cessation of breath-sounds and movements in the lung corresponding to the obstructed bronchus. If the obstruction of the bronchus is incomplete, a whistling sound is heard as the air passes by it, and there is a gradual collapse of the lung, owing to the alveolar air being slowly squeezed out by the elasticity of the lung, which is no longer sufficiently counteracted by the entrance of air during inspiration. As a result of the collapse there is an impaired percussion note. If the foreign body is not removed at once, suppurative bronchitis occurs, and any of the following complications may arise—septic pneumonia, tuberculosis of the lung, empyema, perforation of an abscess into a large bloodvessel, or an abscess may burst externally, and through this the foreign body has been occasionally discharged.

An attempt must be made to remove a foreign body without delay. A skiagraph will in some cases—*e.g.*, when the obstructing agent is a coin—aid in localization. Tracheotomy instruments are got ready to hand, and then the patient is inverted and slapped on the back. If this method fails, a long incision is made into the trachea, and the edges of the trachea are temporarily stitched to the skin on each side. The patient, whilst under the anæsthetic, may be again inverted or simply turned on to his face. A probe is next passed downwards, and if the foreign body can be touched, attempts are made to extract it with suitable forceps. When all these attempts fail, the patient is sent back to bed with the trachea wide open and sutured to the skin. Modifications in instruments are devised, such as the character and position of the foreign body may suggest, and then another attempt is made to get it out.

Fracture of the Larynx.

The hyoid, thyroid, or cricoid cartilages are injured by blows, or are crushed by the grasp of a garroter. The severity of the fracture increases from above downwards, that of the cricoid being fatal at once, unless tracheotomy can be done. The sudden death is due to the obstruction caused by the displaced fragments. A fatal termination may take place later from œdema of the glottis, hæmorrhage, surgical emphysema, or septic necrosis. The cartilages are replaced from within by inserting an elevator or the finger through a tracheotomy wound. Sutures are inserted, if needed, to hold the fragments in place.

Cut Throat.

A suicidal cut throat is generally made most deeply on the left side, at the commencement of the stroke, and tails off towards the right, the reverse being the case for a left-handed man. The injury varies—a scratch, several superficial cuts, chipping or opening of the larynx, division of superficial anterior jugular veins, or branches of the superior thyroid artery. The partial division of the left carotid and jugular is the common fatal wound.

Homicidal cut throat is not necessarily deeper on the left side, but varies with the position of the assailant and his victim. Suicidal wounds may be only superficial, and the patient much frightened and faint; but he may, however, lose much blood from superficial vessels, or even puncture the jugular vein. Death may occur without dividing the carotid by fracture of the larynx, by blood entering the trachea, or by air entering the veins. After this one exhibition of madness, the patient may return to a sane condition, or may still remain mad, and make further attempts at self-destruction, maintain a profound depression detrimental to recovery, or pretend contrition and a sane mind until a moment when he is left unguarded.

All bleeding is first stopped. If artificial respiration is required, the large open veins must first be clamped or covered to prevent the aspiration of air. If the larynx be damaged, a tracheotomy-tube may be required, or it may be sufficient to replace and fix by suture the cartilages. A lateral ligature may be placed on a punctured wound of the jugular vein. A close inspection of the carotid must be made, supposing the sheath to be open. If the wall of the artery has been nicked sufficiently to puncture the elastic coat, the artery may have to be tied in two places, and divided between. However, if the wound is likely to heal readily, a wound of the sheath and outer coat may be closed by fine sutures. If there be no need for a tracheotomy-tube, all communication with the air-passages is shut off by sutures. According to the unfavourable or favourable state of the wound, the superficial part is filled with gauze or sewn up, except for drain-tubes.

A cut throat requires a stimulating diet, purgation, and careful watching against suicidal fits.

Laryngeal Paralysis.

In paralysis of the adductors, no surgical interference is needed; when of the abductors, the respiration becomes impeded. If this paralysis comes on slowly, great narrowing of the glottis may be borne; when rapid—especially where there is some inflammation in addition—tracheotomy may be urgently required. In order to avoid tracheotomy, the thyroid cartilage may be divided, and one or both cords excised. Unfortunately, subsequent narrowing may again occur, owing to cicatricial formation in the mucous membrane.

Respiratory Spasm.

If from local causes, such as foreign bodies, local measures are directed towards their removal. Central spasm may come on in nervous disease—*e.g.*, convulsions of childhood, in which tracheotomy may be done as a matter of urgency, but without affecting the subsequent course.

Œdematous Laryngitis.

This may arise from an accidental wounding or crushing of the larynx, such as in suicidal cut throat, or in garroting, or from corrosive substance swallowed, or is due to hot steam or inflamed gas inhaled; the most rapid of all is from a wasp-sting. Erysipelas may spread to the larynx. General dropsy from renal or cardiac sources may suddenly invade the larynx. If previously stenosed, a very slight increase in the thickness of the mucous membrane is sufficient to cause dangerous dyspnœa. Tracheotomy will be required as soon as possible. Usually the tube can be withdrawn very soon. In slighter cases the epiglottis and ventricular bands may be scarified by means of an angular knife and laryngeal mirror, or this may be done by guiding a guarded knife with the finger. An intubation tube may be inserted for a short time.

Subacute and Chronic Laryngitis.

Cold air and over-use of the voice are common causes. An impairment of health specially predisposes to the condition by increasing the susceptibility to catarrh, whilst anæmia diminishes muscular force. Cold air taken in through the mouth instead of the nose, owing to actually existing obstruction or owing to the habit of breathing through the mouth acquired in youth, living on a cold and damp soil, dust and tobacco smoke, make the laryngitis worse. Over-use of the voice by hawkers is made worse by exposure to bad weather or by alcohol. Public speakers who put an unnecessary strain upon the voice, or who speak much in ill-ventilated rooms whilst out of health, are often the subjects of chronic laryngitis.

The treatment is directed to the removal of the cause or causes. Inhalations and expectorants are useful in the subacute stage, astringent applications in the chronic stage.

Laryngeal Ulceration.

Excepting traumatic ulcers and occasional cases following the specific fevers—small-pox and typhoid fever—ulcers are either tubercular, syphilitic, or malignant. The diagnosis is made on general grounds. Tubercular ulceration, except for rare cases of lupus, is secondary to tuberculosis of the lungs, and continues to progress from small nodules to ulcers, with swelling over the arytenoid cartilages and gradual destruction of the epiglottis. It does not tend to spontaneous healing and cicatrization. Tubercle bacilli may be found in scrapings or in the sputa. Syphilitic ulcers are of the secondary and tertiary type. They tend to spread and cause necrosis of cartilage, followed by scarring and contraction. Pain, cough, and dysphagia are relieved by sprays containing cocain or menthol, or by insufflations of morphine and iodoform powders. An application before meals aids swallowing; fluids can sometimes be best taken by sucking them up through a tube whilst lying prone.

Diphtheria causing Laryngeal Obstruction.

The larynx becomes involved in diphtheria by extension from the fauces, and this is to be prevented by active treatment of the fauces, and by the administration of antitoxin. The signs of the extension are the gradual increase of laryngeal stridor, increasing dyspnœa causing cyanosis; the larynx moves up and down with respiration, and there is marked recession of the chest along the line of attachment of the diaphragm, occurring with each inspiration.

Tracheotomy should be done early whenever dyspnœa and recession of the chest have set in. Apart from actually relieving the obstruction, the tracheotomy gives access to the larynx, from which the membrane may be cleared, and extension to the trachea and bronchi checked.

Laryngeal Stenosis.

Laryngeal stenosis is produced by scar tissue and loss of rigidity of the cartilaginous framework. Scar tissue and fibrillation of cartilage is produced by ulceration, perichondritis, and abscesses. The chief cause is syphilis, next tuberculosis, and more rarely typhoid fever, small-pox, and other specific fevers. Occasionally injury or the impaction of a foreign body has been the cause. Besides medicinal treatment directed towards the relief of the ulceration, dilatation is kept up by the passage of hollow tubes or catheters, guided by the mirror or by a finger on the epiglottis, or straight metal intubation tubes may be introduced. Neither catheterism nor intubation is of much avail when the cartilaginous framework has been softened. Thyrotomy may be done, and the scar tissue cut away from the interior of the larynx, together with what remains of the vocal cords, in the hope that by this means the patient may escape from the necessity of having to wear a tracheotomy-tube for the rest of his life.

New Growths of the Larynx.

Non-Malignant New Growths.—Multiple papillomata are composed of granulation tissue, and are produced by a tracheotomy-tube which is not removed early. As a result, the larynx becomes blocked above the tube by soft masses. Multiple papillomata are plucked and scraped away through the tracheotomy wound, and the tracheotomy-tube is not replaced.

Multiple papillomata occur also in children after measles and other specific fevers. They may be plucked away when the child is anæsthetized by chloroform and cocain, guided by a mirror; or the larynx may be viewed directly when the head is hanging low, and a speculum has been introduced into the mouth. Papillomata, nævoid tumours, mucous polypi, or cysts, occur singly in adults from unknown causes, and may be removed under cocain by forceps or the snare guided by the mirror.

Malignant New Growth—Epithelioma.—The most important is an epitheliomatous growth on the vocal cord. It is essential that a very early diagnosis should be made, and the growth distinguished from syphilis and tubercle. An epithelioma commences on a vocal cord by a warty outgrowth or by an ulcer, which hinders the movement of the vocal cord out of proportion to the superficial extent of the disease, owing to the deep induration which takes place. There is no soreness corresponding to the diminished movement of the cord. An early diagnosis is made by noting a steady increase of the foregoing symptoms, whilst tubercle bacilli are found to be absent, and no improvement follows on the administration of iodide of potassium and mercury. If epithelioma is diagnosed at this stage, thyrotomy is done and the tumour excised, and the prognosis as regards cure after this operation is good, while the voice recovers in a large measure.

The further course of malignant disease is marked by aching pain, hæmorrhage, extension outside the larynx, invasion of lymphatic glands. But it must be again insisted on that a diagnosis ought to be made before any of these latter signs appear. When the disease has reached this stage, the only treatment is complete excision of the larynx.

When the disease is beyond the limits of a complete excision, a palliative tracheotomy is performed, iodoform is freely dusted on the growth, and opium and morphine are given as required.

Intralaryngeal Operations.

Intralaryngeal operations are done after painting 20 per cent. cocain hydrochlorate upon the soft palate, pharynx, and larynx. In children sufficient chloroform must be given cautiously, so as to keep them still and the mouth open.

Scarification.—A guarded knife, the shank bent to a right angle, the blade protruded by a spring, may be used. Or a curved bistoury may be guarded up to its point by winding strapping round it, and scarifying under the guidance of the fingers. Iodoform can be afterwards inflated.

Curetting.—Tubercular ulcers can be scraped by a suitably curved curette and lactic acid, 10 to 70 per cent., well rubbed in. This method is suitable for tubercular ulcers when single and not attended by any marked disease of the lungs. In the majority of cases this treatment is unsuitable on account of the ulceration being secondary to the pulmonary disease, with continual expectoration of bacilli.

Snare.—Pedunculated tumours of the larynx can be removed with the galvano-cautery snare after cocainization, guided by the mirror. The galvano-cautery point can be used to cauterize the base of the tumour.

Forceps.—These have the shank bent at a right angle, and the jaws opening either antero-posteriorly or laterally. They may be used for the removal of foreign bodies and simple sessile tumours. They should not be used for malignant growths, except to take away a piece for microscopic examination; this may yield positive information, but negative evidence is of no value, for the superficial portion of some malignant growths may have cell structures resembling simple ones.

Extralaryngeal Operations (Figs. 67, 68, and 70).

Thyrotomy, or Laryngo-fissure.—This may be done with the head hanging low without previous tracheotomy, if no marked obstruction be present. In many cases a preliminary tracheotomy is best, the same position being observed. A skin incision is made from the hyoid bone to the cricoid, and the thyroid cartilage carefully divided in the middle line by strong cutting scissors. The epiglottis may be separated by a knife, but this is unnecessary if only the removal of a foreign body or necrosed bone be required. The interior of the larynx can then be examined, and a malignant growth localized. It must be reckoned to extend at least $\frac{1}{4}$ inch beyond the furthest border of the induration.

On one side or on both the soft structures, including the vocal cords, may be cut away. Hæmorrhage can be stopped by sponge pressure, by the cautery, or by plugging with gauze for some hours and keeping in the tube. If the hæmorrhage be unimportant, the tracheotomy-tube is withdrawn, the patient laid on his side with his head low, and iodoform often insufflated at the moment of swallowing.

If the cartilage of one side be involved, it is freed externally, the branches of the superior and inferior thyroid arteries are clamped, and the cornua attached to the hyoid and cricoid cartilages cut across, care being taken not to injure the œsophagus. The wound can be afterwards treated as before described.

The tracheotomy-tube inserted for such operations may be surrounded with a thin layer of sponge, which is rendered antiseptic, dried, soaked in a saturated solution of iodoform in alcohol and ether, and then sewn on to the tube. When inserted, the sponge expands and blocks the trachea.

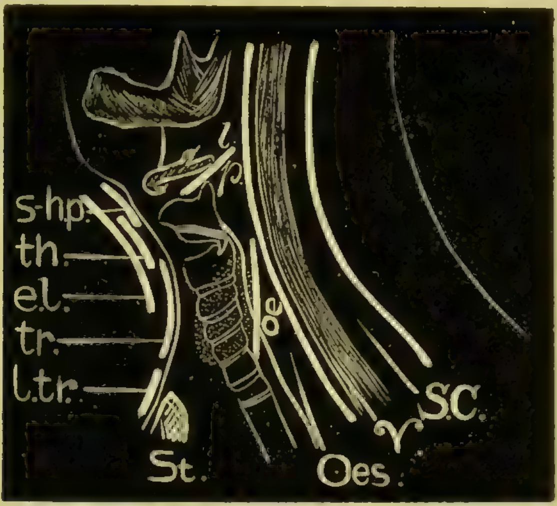


FIG. 67.—INCISIONS IN OPERATIONS UPON THE LARYNX, TRACHEA AND ŒSOPHAGUS.

s-hp, subhyoid pharyngotomy; *lp*, lateral pharyngotomy; *th*, thyrotomy; *e l*, excision of larynx; *tr*, tracheotomy; *l tr*, low tracheotomy; *oe*, œsophagotomy; *St*, sternum; *Oes*, œsophagus; *v*, spinal column; *S C*, spinal cord.

A tampon-cannula, consisting of a rubber collar round the lower end of the tube capable of inflation, may be used; or with the hanging head a simple tube may be put in, and small sponges on threads pushed up from the trachea wound, or pushed down through the cricoid ring as soon as the thyroid cartilage is cut through.

Excision of the Larynx.—A preliminary thyrotomy may be done in order, by palpation, to ensure the nature of the growth and its extent. The tracheotomy may be done at the time or a few days beforehand. The head hangs low.

1. A vertical incision is made with two horizontal ones, one over the thyro-hyoid ligament, and the other over the upper

ring of the trachea, ⌶-shaped, and the skin sufficiently reflected to give room.

2. The trachea is divided transversely below the growth, a thread inserted into the lower end, upon which the anæsthetist can draw, and keep free of mucus, whilst chloroform is blown in.

3. The upper end of the trachea and cricoid are now raised and separated behind and at the sides, the branches of the superior and inferior thyroid being cut across and clamped. The superior laryngeal nerve should be cut cleanly across at once—not first pulled or notched—and its proximal end after division should not be irritated in any way, so as to avoid arrest of respiration and shock.

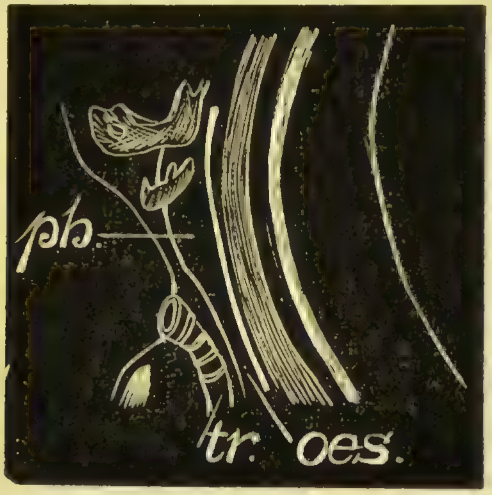


FIG. 68.—DIAGRAM OF NECK AFTER COMPLETE EXCISION OF THE LARYNX. *ph*, Pharynx; *oes*, œsophagus; *tr*, trachea.

The epiglottis may require removal, or its upper part may be left attached to the hyoid bone. The thyro-hyoid ligaments and cornua are cut across, taking care not to injure the lingual artery, and as much as is needed of the junction of the œsophagus with the pharynx is cut away with scissors. Any enlarged glands are excised.

There is then left a wide opening into the pharynx (Fig. 68) below the tongue, leading into the œsophagus. This is sewn up by a vertical continuous suture including the mucous membrane. A second suture follows superficial to the first, burying it by drawing the muscular walls of the pharynx together without piercing the mucous membrane. The trachea is stitched to the lower end of the wound, and the skin is brought together—except at the lower part—just above the trachea, where can be inserted a drain or a strip of gauze, or the opening be simply left patent. The patient must be fed by the rectum for a few days; small quantities may be then given by the mouth, or a stomach-tube may be passed with care. The air has to be kept moist and of a constant temperature. Patients so treated can afterwards speak by driving air into the mouth from the pharynx.

Tracheotomy.—This is generally done through the highest tracheal rings. In children the cricoid has to be divided also in order to get room. Laryngotomy through the crico-thyroid membrane is very rarely done now; even a flat tube is badly borne between the cartilages, and the cords are likely to be damaged by ulceration set up by the tube. It may be reserved for operations of emergency, in which sufficient preparations are wanting. An opening lower down in the trachea may have to be made, but is more difficult.

Tracheotomy may be done hastily by seizing the alæ of the thyroid cartilage between the thumb and finger of the left hand, cutting through the skin in the middle line down to the cartilage, and plunging the knife in above or below the cricoid ring, cutting through the latter in a child. The sides are then held open. If no proper tube is at hand, a free opening may be made, and the skin stitched to the trachea on each side, or a drainage-tube may be temporarily employed.

Tracheotomy for Diphtheria.—A little chloroform should be administered unless the child stops breathing. The head is held extended, with a pillow under the shoulders and neck, exactly straight with the trunk. If the assistant rests his elbows on the table, and has the head between the forearms, he can then retract each side of the wound symmetrically. An incision is made with its centre over the cricoid cartilage, about 1½ inch in length. If this point cannot be detected, nor the thyroid either, then the centre of the incision should be midway between the chin and sternum. With a sharp knife a firm incision is made at once down to the cricoid cartilage. The sides are retracted, including the sterno-hyoid muscles, which should not be cut into with the knife; veins are clamped, a blunt hook draws down the isthmus of the thyroid gland, and the knife is plunged into the first tracheal ring, and, cutting upwards, the cricoid ring is divided; or the knife may first perforate the crico-thyroid space, and the cut be made downwards through the cricoid ring. The point of the knife should not enter more than $\frac{1}{4}$ inch. Whilst cutting, the cricoid can be held with the thumb and finger, or a sharp hook can be inserted at its upper or lower border, so as to draw it forwards. Following the knife is inserted the dilator. Blood and mucus are repeatedly wiped away, for unless the breathing has stopped there should be no hurry about inserting the tube. Any membrane seen is seized with forceps. Small sponges or feathers are passed upwards and downwards, in order to detach membrane, and the tube should not be inserted until all membrane within reach has been removed.

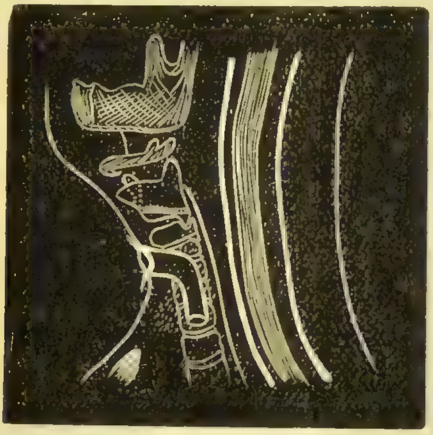


FIG. 69.—TRACHEOTOMY-TUBE IN POSITION.

The tube to be inserted should be curved at an obtuse angle (Parker's), the inner tube being cut away for the purpose (Fig. 69). The objection to the bivalve and other semicircular tubes is that an ulcer which may go on to necrosis forms on the anterior wall, where the end of the tube touches. The tube is tied in with tapes round the neck. The edges of the wound may be carefully painted with strong carbolic acid, iodoform dusted on, and a warm sponge kept in front of the tube. After the operation, moist warm air is needed to avoid pulmonary complications, but, more important still, plenty of oxygen, for it is of want of this that the child will die. Thus, a tent and steam-kettle are only needed in cold weather and in draughty rooms. A large room of uniform temperature, with plenty of fresh air, and with a steam-kettle a little distance off, is best.

After the operation, feeding is of great importance; nutrient enemas will often be required. The child must not sit up suddenly until quite convalescent. The cases do much better now that diphtheritic antitoxin is also used.

Iodoform may be applied to the wound. If it become diphtheritic, the membrane is peeled off, and strong carbolic acid painted on. The tubes are cleaned in hot soda-water. All sponges and feathers used must be afterwards burnt. No nurse should go near a tracheotomy case who does not understand the danger of infection from the material coughed up, whether to the mouth or eyes or to any wound. No suction by the mouth must ever be made; it is most dangerous, and can hardly be of any use. Sponging, seizing by forceps, and suction by means of a syringe, are the only permissible methods of removing the membrane. The tube must be taken out as soon as possible. In many slight cases it can be left out for a few hours on the third day, being replaced at night for a little time longer. Vulcanite or rubber tubes may be substituted for the silver one, but every effort must be made to get rid of the tube by the end of three weeks.

Complications from wearing Tubes.—The larynx falls together, and granulations form and block it. If the child is sent out with a tube, it is not only prevented from speaking, but is almost certain to meet with some accident, such as the breaking of the tube, the tube being pulled out by playmates, etc., and in consequence sudden death.

Tracheotomy in Adults is done through the second and third tracheal rings, and is a most easy operation when not complicated by an external tumour. It becomes very difficult when a malignant tumour of the thyroid gland or larynx is the cause of the dyspnœa, or an aneurysm rises up into the neck. The tube has to be inserted above the tumour when it is an aneurysm, below the tumour when laryngeal cancer, or by cutting through the middle of the growth when a malignant bronchocele. The trachea in the last case may have been displaced, or compressed laterally so as to be shaped like a scabbard. The thyroid or cricoid being felt, the incision is made exactly in the middle line through the growth, bleeding being checked by clamps and sponges. The incision is begun below the cricoid, and the trachea tracked downwards through the growth until, a tube being passed, breathing becomes free. A tube may be required long enough to reach almost to the bifurcation when the growth involves the root of the neck.

It is best in such cases to use no general anæsthetic. Chloride of ethyl, or cocain, or ice, will lessen the pain of cutting through the skin ; but the patient is often sufficiently anæsthetized by the cyanosis. If a general anæsthetic be given, the patient may become suddenly asphyxiated, and it is then very difficult to get into the trachea before the heart ceases.

Plastic Operations have been done upon the trachea involved in a growth, or for the closure of a tracheotomy fistula, by turning in flaps of skin. The trachea may also be dilated, when strictured from simple causes, like other mucous tubes, viz., by a longitudinal incision and dilatation by bougies through the opening.

Intubation.—Special tubes may be inserted so as to remain in the larynx, either under the guidance of the finger passed down to the larynx, or of the mirror. Some practice on the cadaver is advisable. Intubation may be employed for œdema glottidis, and for threatened stenosis.

The objections to intubation are the collection of diphtheritic membrane below the tube, and the helplessness of the nurse—unless specially trained—should the tube become blocked or displaced.

CHAPTER XXV.

SURGERY OF THE NECK.

Septic Inflammation.

SEPTIC inflammation, or 'Ludwig's angina,' is a dangerous condition, which is often rapidly fatal. It consists in an inflammatory œdema infiltrating the structures beneath the deep fascia, causing a brawny induration and the development of multiple abscesses. The inflammation spreads rapidly to the mediastina, pleuræ, and lungs, and death occurs from septic pneumonia. The origin of the septic inflammation is from necrosed bone, from necrosis of the lower jaw due to carious teeth or phosphorus-poisoning, from syphilitic necrosis of the palate and nose, from necrosis of the temporal bone due to ear disease, the infection spreading to the neck by way of the internal jugular vein. The abscesses which form contain stinking pus, and their walls consist of sloughing connective tissue. Any brawny swelling must be at once explored by making a short incision and pushing forceps in. In this way the tissues may drain, and the extensive destruction which produces an abscess be avoided. The only way of checking extension is by the early opening of every focus of suppuration. The abscess cavities are wiped out by a strong antiseptic.

Enlargement of Lymphatic Glands.

The sublingual lymph glands enlarge, on account of irritation, from the lips and front of the mouth ; the submaxillary lymph glands from the face, nose, side of mouth, and tongue ; the pre-auricular gland from the upper face, eye, and orbit ; the post-auricular gland from the auricle, middle ear, and adjacent part of the scalp; the post-cervical glands from the scalp; the sterno-mastoid glands from the fauces, tonsil, pharynx, and middle ear; the carotid glands from the neck, pharynx, and larynx, and by extension from the submaxillary, or upwards from the thorax, in cases of malignant disease.

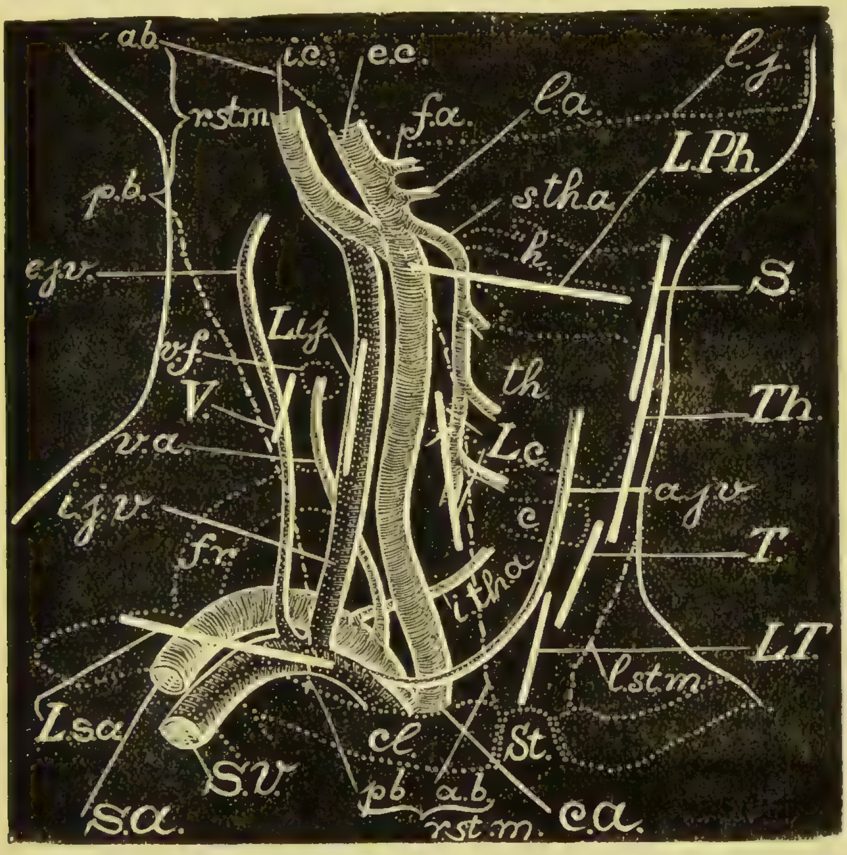


FIG. 70.—DIAGRAM OF THE VESSELS OF THE NECK, AND LINES OF INCISIONS.

l j, Lower jaw; *h*, hyoid bone; *th*, thyroid cartilage; *c*, cricoid cartilage; *st*, sternum; *cl*, clavicle; *f r*, first rib; *r st m*, right sterno-mastoid muscle; *a b*, its anterior border, *p b*, its posterior border, each marked by an interrupted line; *l st m*, left sterno-mastoid, anterior border; *c a*, right common carotid artery; *i c*, internal carotid; *e c*, external carotid, with branches: *s th a*, superior thyroid, *l a*, lingual, and *f a*, facial arteries; *s a*, right subclavian artery, with branches: *i th a*, inferior thyroid artery, and *v a*, vertebral artery, entering, *v f*, the vertebral foramen; *s v*, right subclavian vein, with branches: *a j v*, anterior jugular, *i j v*, internal jugular, and *e j v*, external jugular veins. Lines of skin incisions: *S*, sub-hyoid pharyngotomy; *L Ph*, lateral pharyngotomy; *Th*, thyrotomy; *T*, tracheotomy; *L T*, low tracheotomy; *L c*, ligature of common carotid; *L s a*, ligature of the third part of the subclavian artery; *L i j*, ligature of the internal jugular vein; *V*, venesection of the external jugular vein.

The glands in the neck show a great tendency to tubercular disease in young people, following upon any kind of irritation. In many cases, however, the mode of entrance of the tubercle bacilli is obscure. They apparently enter through the intact mucous membrane, for although it has been conjectured that the entrance was through the tonsil, yet disease of the tonsil and tubercular glands in the neck very rarely coexist. Diphtheria, primary syphilis, and malignant disease directly infect the glands. Posterior cervical glands are enlarged in secondary syphilis, also in rubella from a generalized infection through the circulation.

Lymphadenoma generally affects the sterno-mastoid glands, sometimes after local irritation ; in others evidence on this point fails.

For treatment see pp. 84 and 85, avoiding injury to important structures.

Congenital Affections of the Neck.

Branchial Appendages, Cysts, and Fistulæ are met with along the anterior border of the sterno-mastoid as far as the sternum. The so-called 'auricular appendage' is a little tag of skin containing a bit of cartilage, and marks the position of the dorsal extremity of a fœtal branchial cleft. A branchial sinus opens on the skin in the above-mentioned line, and may end blindly. Or the opening may terminate in a fistulous communication with the pharynx just behind and below the tonsil, and which can be seen by injecting milk or an aqueous solution of aniline blue into the opening on the skin. The line of this fistula corresponds to that of the first branchial cleft below the hyoid arch. Cysts may be found in this same line. They are distinguished from other cysts in the neck by being unilocular and lined by epithelium. Some are thin-walled, others are thick-walled dermoid cysts. Malignant tumours arise in connection with the same structures, hence the origin of primary epithelial new growths in the neck which are unconnected with the skin, mucous membrane, thyroid or thymus gland.

A careful dissection is required to remove these conditions.

Hydrocele of the Neck.—This is the name which is given to smooth-walled unilocular cysts in the neck, arising by dilatation of connective tissue spaces. It occurs behind the line of the sterno-mastoid in the posterior triangle of the neck, and is thus distinguished from branchial and thyroid cysts.

Hygroma, or Congenital Cystic Tumour of the Neck.—The position of hygroma is the same as the hydrocele, but the tumour is multilocular, with loose, œdematous intercystic tissue. It forms a soft, doughy tumour at the root of the neck of a baby, and, by extension along the planes of deep fascia, involves the axilla or presses on the trachea. Some cysts are more tense than others, and a straw-coloured serous fluid escapes from a puncture. When the disease is strictly localized, a hydrocele or hygroma should be excised. But this cannot be safely done when the disease is extensive in a young child, and it is apt to prove more widespread than appears at first sight. The tissue of which the walls are composed has so small a blood-supply that a little inflammation will cause the tumour to disappear by absorption. The inflammation may arise by chance, or may be induced by injecting a weak solution of iodine in glycerin into the tumour at several points (iodine, grs. x. ; potassium iodide, grs. xxx. ; glycerin, ℥i). In the case of a young baby, only a few drops should be injected into each place.

Aeroceles are rare conditions in which the sacculus laryngis is dilated, or a diverticulum of mucous membrane between the rings of the trachea communicates with a cyst in the deep cervical fascia. In some monkeys there is a normal communication which enables them to inflate the neck at will.

Pneumatocele.—Sometimes the apex of the lung extends high into the neck, and is recognised by auscultation and percussion.

Exostosis growing from the Seventh Cervical Transverse Process.

The exostosis is said to grow from the bit of cartilage which represents a rib. The tumour may have the shape of a rib, or, on the other hand, be shaped like a mushroom. It is seen in young women, and appears as a bony mass in the supraclavicular triangle. If the tumour is painless, nothing need be done. If it presses on the brachial plexus, subclavian artery, or vein, it is excised. The exotosis is cut down upon from behind, the soft structures are easily separated, and the peduncle is broken or cut off.

The Sterno-mastoid Muscle.

Spasmodic Torticollis, causing a painful contraction of the sterno-mastoid muscle, may arise from bad teeth, ear disease, pediculi capitis, spinal caries, or enlarged glands, and is therefore in the first place treated by removing the cause. The spasm may, however, persist, owing to inflammatory changes in the spinal accessory and cervical nerves supplying the muscle. The spinal accessory nerve may be exposed at the anterior border of the sterno-mastoid, and stretched by drawing on it with a hook, and this may be sufficient. In a severe case it must be resected, an inch or more being cut out, or the nerve may be avulsed, *i.e.*, steadily drawn on until it comes away at its roots. This has been done in man, and also in experiments on animals by Claude Bernard and others, so that spinal hæmorrhage need not be feared. It is required when the neuritis has spread up to the root of the nerve. Atrophy of the muscle, and also of the upper part of the trapezius, will, of course, follow to some extent; but both muscles have nerves from the cervical plexus. In the severest type of case it is also necessary to excise the posterior branches of the second, third, and fourth cervical nerves.

Wry Neck.—The sterno-mastoid tumour seen in infants is due to a rupture of muscular fibres at birth, generally happening in breech presentations owing to strain on the after-coming head. Whilst the possibility of its being due to gummata may be admitted, yet this notion is not confirmed by recent operations, in which the scar has been excised and examined microscopically. Therefore, unless the child shows other signs of syphilis, mercury or iodides should not be given.

The treatment is by early extension, the mother being taught to turn the child's chin towards the opposite shoulder when nursing it, so as to keep up extension upon the shortened muscle.

If this be not done, the mastoid process of the injured side is gradually brought nearer to the sternum. Impaired development of the facial bones on that side, lateral curvature —the convexity of the curve being to the opposite side— disturbances of vision, nystagmus, and squint, may follow a delay in treatment. In an early case, which is too firm to yield to extension only, the sternal insertion of the tendon is divided through a small incision, a blunt hook being passed behind the tendon, and the tendon drawn forwards. It is then carefully cut through. The subcutaneous division of the tendon should not be done, for the hand cannot be guided by the eye, and sudden death has been caused by wounding the anterior jugular vein and letting in air. Massage and exercises directed against a recurrence of the deformity encourages the return of the muscles to the normal, whereas a fixed apparatus promotes wasting of the muscles from disuse. The division of the tendon is useless in advanced cases of old standing. The cicatricial mass should then be carefully excised, so as to free both ends of the muscle. It will be found that the anterior and posterior aponeuroses of the muscles are much thickened and of cartilaginous hardness, and that few or no muscle fibres remain in the scar. The scar must be carefully dissected from the carotid sheath and internal jugular vein beneath. The removal may still leave some contraction in the carotid sheath, secondary to the long abnormal position. Steady extension and exercises must be practised, and fixation apparatus avoided if possible.

Arteries and Aneurysms of the Neck (Fig. 70, p. 265; see also Chapter V., p. 70).

The arteries of the neck are of surgical importance in connection with punctured wounds, the removal of tumours, and the formation of aneurysms. The treatment of these conditions is now much less difficult since the introduction of anæsthesia, which allows a sufficiently large wound to be deliberately made, so that each structure can be recognised when exposed. A knowledge of topographical anatomy, and the exercise of discretion in attacking deep-seated tumours, will prevent harm being done. The treatment of aneurysms in the root of the neck is always a very difficult matter.

Aneurysms of the Arch of the Aorta and of the Innominate Artery.

When a prolonged course of medical treatment has failed to relieve, various surgical expedients have been tried, amongst which there are two whose use has been attended by some success.

Simultaneous Ligature of the Common Carotid at the Level of the Cricoid Cartilage, and of the Third Part of the Subclavian Artery.—The rush of blood through the innominate artery is diverted into anastomosing channels, and this is supposed to favour the formation of clot in the aneurysm. Theoretically the method should apply especially to innominate aneurysm, but, as a matter of fact, relief has been afforded to one of the aorta also. When, however, the circulation through the vessels on the distal side of the aneurysm is already less than normal, little relief can be expected from the operation.

Macewen's Needles.—The needles are passed into the projecting part of the aneurysm until the point is felt to be moved by the current, and is allowed to touch the opposite wall of the sac. The method has not proved dangerous in practice. Even if the needle does perforate the posterior wall, there is no more danger of hæmorrhage through it than through the anterior puncture. The detachment of a clot causing the formation of an embolus has not happened.

The Common Carotid Artery.

A large wound causes uncontrollable hæmorrhage and death in a minute or so, as in suicidal or homicidal cut throat or in gunshot wounds. Minute punctured wounds near its bifurcation, and hæmorrhage by gradual ulceration of its coats after an injury, abscess or malignant growth, can be temporarily controlled by direct pressure. The artery can then be tied below, and its two branches just above, the bifurcation. If either the external or internal carotid be left unligatured, free hæmorrhage will continue, owing to anastomosis (see Fig. 71, p. 274).

Aneurysm of the Carotid.

This is the only surgical aneurysm occurring in women which in any way approaches in its frequency of occurrence that in the male sex. The chief general cause is syphilis. There may be evidence of weakening of the outer coats by a previous injury or abscess. The evidence as to strain is very doubtful. An aneurysm occurred in a Hindoo of eighteen after a severe twist in the neck; aneurysms are very rare in India, and no other cause for the disease could be assigned. Spontaneous carotid aneurysm begins at one end or other of the artery. If at the lower end, it is practically an innominate aneurysm; if at the upper end, the aneurysm may extend downwards so as to overlap the artery. A large aneurysm is easily diagnosed.

Two conditions may raise the question of early aneurysm. The carotid lymphatic gland at the bifurcation may enlarge and tend to suppurate. The diagnosis is made by waiting; the skin will soon be involved if there is suppuration. In women and old men, owing to wasting of the platysma and loss of subcutaneous fat, the bifurcation of the common carotid may become so prominent as to seem at first sight an aneurysm. Such a case, being watched, will be found not to increase, and post-mortem examination may show only a large bifurcation.

Ligature of the Common Carotid.

Ligature is required for aneurysms at the bifurcation, or on the internal carotid and its branches, and as a distal ligature in innominate aneurysm. It should never be used for any lesion of the external carotid or its branches. Not only is it an unnecessarily dangerous operation, but hæmorrhage will recur through the external carotid by blood returning down the internal carotid from the circle of Willis (Fig. 71, p. 274).

Its Dangers.—(*a*) Immediate and temporary paresis of the limbs of the opposite side. It has been shown that the clamping of the carotid in a monkey diminishes markedly for an hour or two the blood-supply through the middle cerebral artery to the Rolandic areas. It was more noticeable in patients before the days of general anæsthesia, but may be found even now for some time after recovery from the anæsthesia.

(*b*) Septic infection. This danger should not now occur. It has spread from the wound down the neck, and caused septic pneumonia, pleurisy, and pericarditis. It has been said that injury to the vagus nerve might account for this, but unilateral division of the vagus nerve does not cause any effect, except unilateral paralysis of a vocal cord. The septic infection has spread from within the artery by decomposition of the proximal clot. This, being washed away, has been driven up the opposite carotid, and set up septic softening in the Rolandic areas, and consequently paralysis of the same side as the ligature, quickly fatal in its results. Thus, immediate paresis of the opposite side is due to anæmia, and is unimportant. But paralysis on the same side occurring a few days after, is septic in origin, and a fatal termination may be anticipated. Even if this does not occur, secondary hæmorrhage may be expected to follow septic infection of the wound.

The Operation.—(*a*) The skin incision is about 3 inches in length along the anterior border of the sterno-mastoid. The centre of the incision should be by choice opposite the cricoid cartilage, above the crossing of the omo-hyoid; but it may have to be below the muscle.

(*b*) After cutting through the deep fascia, the edge of the sterno-mastoid is noted and retracted. The artery can then be felt, or even seen, beating in its sheath.

(*c*) The omo-hyoid may have to be drawn down by a hook, a thyroid vein, rarely a small artery, divided between clamps, and the sheath then incised well on the inner side so as to avoid the vein, which overlaps the artery, especially on the left side.

(*d*) The artery is carefully separated from the vagus nerve behind, and from the internal jugular vein on the outer side. The ligature being passed, the artery is lifted, so as to observe that neither the nerve nor vein is included before tying. The tissues are replaced and the wound completely united.

If the artery has been wounded above, or communicates with an abscess, or the aneurysm is already suppurating, it will be best to ligature the external and internal carotid also, and excise the aneurysm. This is much less dangerous than leaving septic matters in the neighbourhood of the proximal ligature. If the internal jugular be wounded, it is sutured, or a lateral ligature applied, or it may be excised between two ligatures without danger, there being free anastomosis for returning venous blood. The vagus nerve should be handled as little as possible, for fear of stimulating cardio-inhibitory and depressor fibres; and this applies more strongly still to the superior laryngeal branch. If the nerve is cut, it should be reunited immediately.

If the aneurysm is an arterio-venous one, a proximal and distal ligature on both vein and arteries will be needed.

Compression of the Carotid Artery.

The carotid artery can be compressed for a short time by the thumb, whilst the fingers grasp the neck. This compression gives rise in some people, at any rate, to signs of anæmia of the sensori-motor area for the arm. Numbness, formications, twitchings, or paresis is experienced in the opposite hand. Temporary compression of both carotids renders the patient unconscious, and hence it was formerly used to relieve epilepsy and convulsions.

The only secure way of temporarily controlling the carotid artery is by passing a ligature round the vessel, so that it can be drawn forwards against the finger. This method may be found useful when a deep punctured wound has to be explored in order to discover the source of the hæmorrhage.

Ligature of both Carotids, if done simultaneously, is followed by coma and death. If an interval of two to three weeks intervenes between the two operations, time is given for the anastomotic circulation to develop.

Ligature of the External Carotid.

Hæmorrhage from a punctured wound below the jaw must be assumed to come from the external carotid or from one of its branches. It is unlikely that any wound of the internal carotid would be otherwise than immediately fatal. The common carotid is compressed, and the wound is enlarged in the line of the external carotid, and both ends of the cut vessel tied. Owing to the free anastomosis, the distal end of the external carotid, or any one of its branches, would bleed freely if not tied.

It is a great mistake to ligature the common carotid for a punctured wound below the jaw. Distal hæmorrhage will continue, not only through the external carotid and its branches, but also the blood returns from the circle of Willis down the internal carotid into the external (see Fig. 71).

Ligature of the external carotid is required when an aneurysm by anastomosis of the scalp is too large to be dealt with by excision. It may be necessary to tie the vessel on both sides.

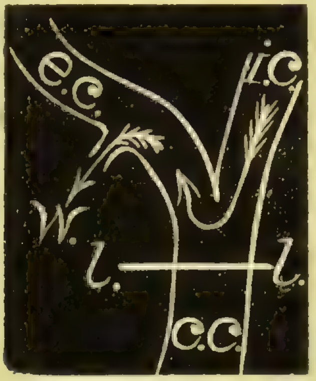


FIG. 71.—RECURRENT HÆMORRHAGE FROM A WOUND OF THE EXTERNAL CAROTID CONTINUING AFTER LIGATURE OF THE COMMON CAROTID.

c c, Common carotid; *ll*, position of ligature; *e c*, external carotid; *i c*, internal carotid. Arrows mark the direction of the blood flow.

Ligature of one external carotid does not diminish the hæmorrhage caused by the removal of the upper jaw. A ligature of both vessels may be useful in diminishing hæmorrhage from a large malignant growth of the nose or naso-pharynx.

The incision is made in the line of the artery, the sterno-mastoid is retracted; the digastric and stylohyoid muscles are also retracted or divided. Veins are divided between clamp-forceps. Any branch arising near the site of the ligature should be also tied to prevent distal hæmorrhage.

The Superior Thyroid Artery.

A ligature of the artery is required in cases of goitre, either as the preliminary to excision, or with the object of lessening the size of the goitre by cutting off its blood-supply. The artery is sought for near its origin, close by the great cornu of the hyoid bone, or just before the entrance of the artery into the lateral lobe of the thyroid gland at its upper, posterior, and inner aspect. The artery and its branches have to be ligatured in excising the larynx, and when divided in cut-throat wounds.

Ligature of the Lingual Artery.

The lingual artery is ligatured as a preliminary to excision of the tongue. When there is continuous hæmorrhage from an inoperable cancer of the tongue, both linguals must be tied, for there is a free anastomosis between the two sides in the new growth, although there is but little anastomosis between the two sides in the normal tongue. The operation is described on pp. 237, 238.

Ligature of the Facial Artery.

The facial artery is ligatured in the course of removing the submaxillary lymphatic and salivary glands, also in excising the lower jaw. The distal end is tied on the face, the proximal just in front of the posterior belly of the digastric (see p. 238).

Ligature of the Temporal Artery.

The temporal artery is ligatured just in front of the ear, or higher up, either for wounds or for a cirsoid aneurysm of the scalp.

Ligature of the Occipital Artery.

The occipital artery can be tied beyond the point where it becomes superficial—viz., midway between the mastoid and the occipital process, either for wounds or tumours. The external carotid may be tied instead.

The middle meningeal artery is too deep to be ligatured in the neck. If hæmorrhage caused by a fractured skull cannot be checked (see p. 169), the external carotid is tied above and below its point of origin.

The Internal Maxillary Artery.

Its branches are torn in removing the upper jaw, and are cut in the course of operations on the third division of the fifth nerve. The artery may be wounded in operations about the temporo-maxillary joint, and in excising the lower jaw. The bleeding vessels must be separately tied.

The Internal Carotid Artery.

Aneurysm of the Internal Carotid—Arterio-venous Aneurysm of the Cavernous Sinus and Orbit —Intra-orbital Aneurysm.

An arterio-venous aneurysm forms owing to leakage into the cavernous sinus from the terminal branches of the internal carotid, the ophthalmic or anterior communicating artery. The aneurysm follows a blow or strain, and causes a bruit, which is heard both by the patient and on the application of a stethoscope to the top of the head; there is also venous obstruction, causing exophthalmos and pulsation of the eyeball. These symptoms are diminished, or stop altogether, whilst the carotid is compressed. If there is an aneurysmal varix, the condition remains stationary; if a varicose aneurysm has formed and the symptoms progress, active treatment is required. Compression of the eyeball and compression of the carotid cannot be kept up long enough to allow of the formation of a clot. But when the pulsation is stopped by compression of the carotid, ligature is the more readily undertaken. Ligature of the common carotid is done, since it is an easier operation than ligature of the internal. When the aneurysm communicates with both sides, the other carotid must be also ligatured after an interval.

The Internal Carotid and Ingravescent Apoplexy.

A ligature of the common carotid artery cuts off for some time much of the blood flowing through the corresponding middle cerebral artery. If the lenticulo-striate artery of a monkey be divided, and then the carotid compressed, bleeding will stop, and a clot form in the mouth of the divided artery. The lenticulo-striate artery is practically a continuation of the internal, and therefore of the common, carotid, and thus receives an extra strain from the blood-stream. This fact is confirmed by the frequency with which this vessel becomes diseased and ruptures; hence it has been called 'the artery of cerebral hæmorrhage.' These considerations have suggested the treatment of ingravescent apoplexy by ligature of the common carotid, and some success has followed.

It is very rare to meet with a punctured wound of the internal carotid not immediately fatal. The common carotid would be compressed, the bleeding-point sought for, and the artery tied above and below.

Ligature of the Innominate Artery for Subclavian Aneurysm.

An aneurysm of the first or second part of the right subclavian artery may leave no free or healthy artery on its proximal side, except the innominate. This artery is generally healthy, and over fifty cases of ligature have been recorded; unfortunately, the earlier cases nearly all died of secondary hæmorrhage. But subclavian aneurysm is very painful from pressure on the nerves going to the arm, and the patients suffer agonies in the later stages of the disease. Fortunately, the most recent operations have been successful, and this has been chiefly due to the simultaneous ligature of the common carotid, which prevents blood from regurgitating down the carotid into the right subclavian, and disturbing the clot on the distal side of the ligature. The carotid, moreover, acts as a guide to the innominate well to the inner side of the internal jugular vein and vagus nerve. A median incision is made down to the sternum, and the sterno-hyoid and sterno-thyroid muscles retracted, whilst the head is thrown well back. The carotid is exposed in this way, and, if the bifurcation is fairly high, the innominate also. When the bifurcation is low, the sterno-hyoid, sterno-thyroid, and sterno-mastoid are divided by a horizontal incision outwards to a variable extent, the muscles being afterwards sutured into position. But the division of muscles, as well as the excision of the manubrium or end of the clavicle, must be avoided if possible, for the wound cannot drain well; nor can firm pressure be applied in the bandaging. Hence blood-clot may collect in the space left, followed by suppuration and secondary hæmorrhage. When little or no muscle is divided, no such cavity is made. The wound must be sewn up completely, for the track of a drain has induced secondary hæmorrhage.

Ligature of the First Part of the Subclavian Artery.

This cannot be anything else than a dangerous and difficult operation, on account of the depth of the artery, its numerous branches, amongst a plexus of nerves—cardio-inhibitory, depressor, laryngeal, pulmonary, œsophageal, and gastric—the injury to any of which may set up important complications. In front of the artery is the junction of the internal jugular and subclavian vein, and the right thoracic duct with the right brachio-cephalic vein. All the early operations ended fatally. Success has been recently obtained by tying the artery just at the inner border of the scalenus anticus, by the operation described below for the second part.

Ligature of the First Part of the Left Subclavian.

This has not been done. It could only be got at from behind by cutting away ribs and opening the pleura.

Ligature of the Second Part of the Right Subclavian.

This is required for aneurysm of the third part, and has been of late years successfully accomplished. An incision is made over the clavicle, and the clavicular head of the sterno-mastoid is divided. The subclavian vein and its junction with the internal jugular must be avoided. When the anterior scalene is exposed, it is divided, taking care not to injure the phrenic nerve. The passage of the ligature requires great care, to avoid puncturing the dome of the pleura, upon which the artery lies, and which is blown up into the wound in forced expiration.

Ligature of the Second Part of the Left Subclavian.

This is more difficult than on the right; the artery is rather deeper, and the thoracic duct may be wounded, as happened in the early cases. A chyle fistula, or the ligature of all the branches by which the thoracic duct terminates, causes wasting and death.

Ligature of the Third Part of the Subclavian Artery.

This is required for spontaneous axillary aneurysm, in distal ligature for an innominate aneurysm, or as a preliminary to amputation of the upper extremity. It is not the proper treatment for a wound or traumatic aneurysm of the axillary artery. It is not necessary before amputating at the shoulder-joint, for the artery can be tied in the axilla. The arm is well drawn down, the skin is divided along the middle third of the clavicle, the deep fascia is divided and the external jugular vein clamped or retracted, the posterior border of the sterno-mastoid and then of the anterior scalene is made out, and the latter is followed down to the tubercle on the first rib. The artery runs immediately outside and behind this point. In front and below is the subclavian vein; close to or in front of the artery is the lowest cord of the brachial plexus. The artery is red, pulsating, and compressible; the cord white, incompressible, and without pulsation when separated from the artery. The effect on the pulse of compressing the vessel must always be noted after passing the ligature, but before tying it.

Compression of the artery is done by pressure with the thumbs at this spot, or by means of a key pressing on a pad; or a temporary loop may be passed, and the artery drawn up against the finger. Compression is employed while exploring a punctured wound in the axilla, or when operating upon a traumatic axillary aneurysm.

Ligature of the Inferior Thyroid Artery.

The inferior thyroid artery may be ligatured just before it enters the lower and deeper part of a bronchocele, but special care has to be taken to avoid the recurrent laryngeal nerve, which often passes in front of the artery. It may also be reached by the incision for the vertebral artery.

Ligature of the Vertebral Artery.

An incision is made along the posterior border of the sterno-mastoid muscle, the muscle is drawn forwards, and the artery sought for as it enters the sixth cervical transverse process, or it may be ligatured above this transverse process, between it and the fifth. The operation has been necessary for a wound and traumatic aneurysm. The vertebrals have been ligatured in the hope of relieving epilepsy, but the operation is quite useless.

Nerves of the Brachial Plexus.

Nerves of the brachial plexus are wounded by stabs, or lacerated by a fractured clavicle, or ruptured by a strain. If seen in a wound, the cords must be reunited by suture. If paralysis follows laceration, and no improvement quickly takes place, the nerves should be cut down upon and reunited. This especially applies if important strands going to the arm are involved.

The brachial plexus may be partly compressed by tumours, by enlarged glands, by callus following a fractured and badly-united clavicle, by an exostosis growing from the vertebræ. In such cases, removal of the cause is indicated.

Brachial Neuralgia may be primary or secondary by extension from the arm. The strands involved may be stretched or divided, or, if the neuralgia has spread to the spinal cord —as shown by involving the dorsal spinal branches—the strands affected must be avulsed by steadily drawing on them until they come away at their junction with the cord. Naturally, the strands composing the median and ulnar nerves should be avoided if possible.

Veins of the Neck. See also p. 77.

Ligature of the Internal Jugular Vein may prevent the extension of septic inflammation from a suppurating clot in the lateral sinus. A portion of the vein may have to be excised in order to remove lymphatic glands affected by malignant disease. If there is only a puncture, the continuity may be preserved by using a suture or lateral ligature. An incision is made over the course of the vein, the sterno-mastoid retracted, the vein separated carefully, and tied above and below. When done to prevent the extension of middle-ear complications, the upper end is fixed in the highest angle of the skin incision.

Ligature of the Subclavian Vein.—A laceration of the vein may occur in compound fracture of the clavicle, or the vein may be injured during the removal of a tumour. The wound in the vein must be closed by a lateral ligature or suture. Occlusion of the whole lumen incurs a grave risk from venous stasis going on to gangrene. The return of venous blood is assisted by elevation of the arm, stroking upwards or bandaging.

The External Jugular Vein.—Venesection is done for the relief of dilatation of a right auricle, which threatens to cease pulsating from being overloaded. The distended vein is fixed by the finger, a nick made into it, and from half to one pint of blood allowed to escape. If the patient makes a sudden gasp, the vein must be pressed upon at or below the wound to prevent the entrance of air. The bleeding stops on the application of a pad and pressure. Should it not do so, a hare-lip pin or long needle is made to transfix the puncture, and a ligature is wound round in a figure of eight, the sharp ends being guarded by cork.

The Thyroid Gland.

Its isthmus lies on the second to the fourth tracheal ring, with which it is closely connected by fascia. The lateral lobes extend as high as the thyroid cartilage, and below to the sixth tracheal ring, and at the sides partly overlap the carotid. When enlarged, the lateral lobe extends as far as the hyoid bone, or even to the lower jaw in the carotid triangle; the lower ends fill up the suprasternal or jugular fossa; the lateral lobes press forwards the sterno-mastoid and approach the vertebræ behind. On the inner surface the enlargement brings the lobes more and more in contact with the pharynx, œsophagus, and trachea, compressing the latter from side to side so as to reduce it to the shape of a scabbard.

An enlarged goitre displaces the carotid. Sometimes the vessel lies behind, or is pushed outwards beyond the internal jugular vein, or the carotid may be pushed forwards, and be felt as a large pulsating cord across the tumour close beneath the skin.

The superior thyroid artery runs below the cornu of the hyoid bone beneath the omo-hyoid and sterno-hyoid muscles, and may be exposed by retracting inwards the upper end of the omo-hyoid. It gives off the superior laryngeal artery next the crico-thyroid branch, which runs along the upper border of the isthmus. The artery reaches the gland on the anterior and inner side of the lateral lobe, where it gives off one branch to the external and posterior part, and one for the front. The superior thyroid has been found enlarged to the size of the carotid, with very thin walls. The inferior thyroid artery passes behind the carotid, and the vagus and sympathetic nerves to the lower end of the lateral lobe. One branch supplies the lower end of the lateral lobe ; the other runs upwards with the recurrent laryngeal nerve to the larynx (Fig. 72).

The internal jugular vein may lie across the tumour in front, or may be pushed aside beyond the outer border of the sterno-mastoid.

The superior, inferior, and middle thyroid (vena thryroidea ima) veins are doubled in goitre by the addition of an accessory vein. In addition there may be a plexus of communication between the external and anterior jugulars. The walls of cystic goitres contain veins, which are easily ruptured and fill the cavity with blood.

The superior laryngeal nerve is only endangered when a goitre extends high up, and the nerve becomes adherent to the capsule ; it lies behind the superior laryngeal artery. If it should be drawn upon, the excitation checks respiration and slows the heart.

The recurrent laryngeal nerve lies behind and to the inner side of the thyroid, and may be involved in the capsule of a large goitre. It may be paralyzed before operation, and the left nerve is more liable to pressure than the right. When paralysis is observed before operation, it points to a severe complication, especially adhesions or malignant infiltration, probably including the tracheal wall.

The nerve should run behind the inferior thyroid artery, but it may be in front or amongst several branches. Whether paralyzed before or during the operation, respiratory dyspnœa is caused, rendering tracheotomy necessary, and tending to set up pneumonia.

The cilio-spinal fibres to the iris are liable to excitation or paralysis, especially on the left side. In benign goitre the change in the pupil is generally unilateral, in malignant goitre bilateral.

The Thyro-glossal Duct.—From the pyramidal lobe there extends upwards to the foramen cæcum of the tongue a chain of epithelial cells, which may form a tube sufficient to allow the passage of a probe. This duct passes in front, or behind, or even through, the body of the hyoid bone, and above it lies between the genio-hyoglossi muscles. A cyst or tumour may appear on the dorsum of the tongue at the foramen cæcum, beneath the chin between the genio-hyoglossi, in front or below and behind the hyoid bone, or be continuous with an enlarged pyramidal lobe.

Accessory Thyroids are detached portions of the thyroid gland, sometimes single, sometimes appearing like a chain of enlarged lymph glands. They may appear above the lateral lobes, about the great cornu of the hyoid bone, and behind the pharynx, coalescing with, or actually protruding into, the lumen of the larynx or trachea, especially on the posterior wall, behind the sternum, or behind or above the clavicles.

Disease of the Thyroid Gland.

It has an endemic origin in certain mountainous regions, such as parts of Switzerland, the Peak district of Derbyshire, parts of the Himalayas. The cause, where endemic, has been traced to the water drunk, but as yet no further.

Another point is that the sporadic forms of thyroid disease such as are seen in this country occur much more frequently in women than in men.

Acute thyroiditis is a rare disease. It may be relieved by the administration of full doses of quinine.

Abscess in the thyroid is also very rare. It is generally secondary and of pyæmic origin.

Syphilis and tubercle of the thyroid are likewise rare conditions.

Bronchocele.

A general enlargement of the gland occurs usually in women, and seems to be induced by anæmia.

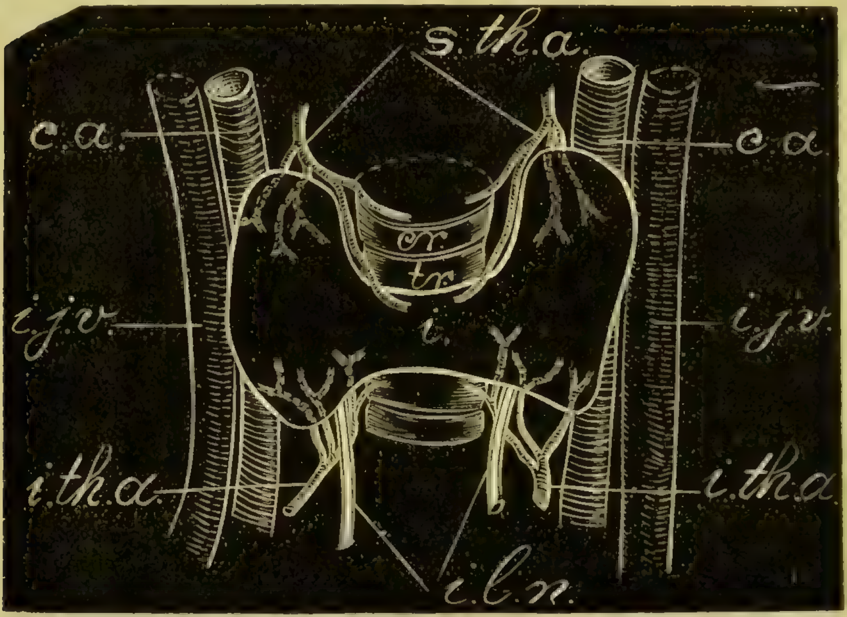


FIG. 72.—BLOODVESSELS IN RELATION WITH THE THYROID GLAND.

c a, Common carotid artery; *s th a*, superior thyroid artery and branches; *i th a*, inferior thyroid artery and branches; *i j v*, internal jugular vein; *i l n*, inferior or recurrent laryngeal nerve; *cr*, cricoid cartilage; *tr*, trachea; *i*, isthmus of thyroid gland.

Exophthalmic Goitre is bronchocele attended by vascular and nervous complications. The tumour appears very vascular, the carotids and the whole tumour pulsating; the heart beats very rapidly, the eyeballs protrude, and the conjunctiva may be deeply congested and swollen. Along with these there are nervous tremors and muscular debility. The patients are usually anæmic young women. The pulse may get faster and faster, until it exceeds 200, and the patient dies suddenly; or the tumour compresses the trachea and extends behind the sternum, and causes death by suffocation; or the disease may remain chronic for a long time, and slowly subside. The changes in the gland indicate, along with the increased vascularity, oversecretion.

The treatment consists in applying iodine and iodide ointment locally, also administering the iodide of iron and quinine internally. The rapid heart may be relieved by belladonna. Administration of the thymus gland diminishes the symptoms of exophthalmic goitre, whilst that of the thyroid causes them to increase. The safest surgical measure is the division of the isthmus between ligatures, with resection of a little of the gland on either side. This sets up atrophy. A more severe treatment consists in partial removal, and in ligature of the bloodvessels. But the patients are very unsuitable cases for any severe operation.

Benign Tumours of the Thyroid.

Encapsuled Adenomas form in the gland. They easily undergo myxomatous degeneration, and produce cysts, into which blood is extravasated. Adenomas and cysts are easily shelled out after dividing the capsule and healthy tissue covering them.

Multilocular Cystic Goitre is a more extensive disease, involving the gland widely. It may cause severe symptoms of dyspnœa owing to pressure on the trachea, or by being wedged behind the sternum. The removal of the tumour is indicated. But a little of the thyroid gland must be left in order to avoid cachexia strumipriva.

Malignant Disease of the Thyroid.

Sarcoma or carcinoma grows rapidly. The growth quickly infiltrates the trachea, paralyzes the recurrent laryngeal nerves, and extends beyond the capsule into the neck. It is difficult to diagnose a case early without an exploratory incision, and it is only in the very early cases that a removal can be done. A palliative tracheotomy, with the insertion of an extra long tube, may temporarily relieve the respiratory difficulty.

Excision of a Goitre.

In all operations on the thyroid gland very little of the anæsthetic is given. A transverse incision, curved with its convexity downwards, is made when the tumour is large and bilateral. An angular incision, one limb vertical, the other transverse, may be employed for a unilateral tumour. The incision used must be long enough to expose the tumour and to allow of ligature of the vessels. The platysma and deep fascia are divided and the veins clamped. The sterno-hyoid and sterno-thyroid muscles are pushed to one side or divided, and the sterno-mastoids retracted or the anterior edge nicked. The capsule of the tumour is now defined, the veins being one after the other divided between clamp forceps. The goitre is gently drawn forwards, and the superior and inferior thyroid vessels ligatured one after the other. Great care must be taken not to tear them. This is done on one or both sides. Then the isthmus is carefully freed. There remains the posterior and lower portion of the lateral lobes attached to the trachea, and closely adherent to the recurrent laryngeal nerve, from which the goitre is cut away, leaving the piece behind. Thus injury to the recurrent is avoided, and a bit of thyroid tissue remains to protect against myxœdema.

The objection to the removal of the thyroid for malignant disease is the uncertainty of cure, together with the probability of injury to the trachea and to the recurrents, as well as of setting up myxœdema by removing the whole gland.

It is important to avoid tracheotomy if possible, on account of the wound complications, but it may have to be done where the cartilages of the trachea are already softened and the trachea reduced to a membranous tube.

The Thymus Gland.

The thymus gland becomes enlarged, especially in young children, and causes dyspnœa, which often sets in suddenly. A fulness may be felt in the root of the neck, and dulness be found behind the sternum. The dyspnœa is not relieved by tracheotomy. The thymus gland has been exposed through an incision, and withdrawn from its position behind the sternum, also partly resected, and so the dyspnœa has been successfully relieved.

Cysts and abscesses also occur in the thymus with the above symptoms; an attempt should be made to evacuate them.

CHAPTER XXVI.

SURGERY OF THE THORAX.

Wounds.

SUPERFICIAL non-penetrating wounds are distinguished from those which penetrate by negative signs—*i.e.*, the absence of hæmoptysis, emphysema, pneumothorax, and by the unaltered breath-sounds. A wound, however, of the anterior or posterior mediastinum, or of the pericardium, is not thereby excluded. A wounded and bleeding intercostal or internal mammary artery is sought for by enlarging the wound, removing a piece of rib if necessary.

Penetrating wounds may be due to a stab, or be caused by a bullet, or be lacerated—*e.g.*, by the bursting of a shell. The signs of penetration are the escape of blood mixed with air at each expiration, or, if the wound be small, the collection of air in the pleural cavity giving a tympanitic note whilst the lung is compressed and the breath-sounds diminished; or blood may collect in the pleura and cause dulness with increasing anæmia.

A wound of the lung is indicated by hæmoptysis. A stab on the left side about the sixth to the eighth ribs, if not wounding the heart, may puncture the diaphragm, through which puncture omentum generally protrudes. Such a stab may injure the stomach, especially when full, and a similar wound on the right side may pierce both diaphragm and liver, and be attended by a flow of venous blood as compared with the bright and frothy blood of the lungs. A stab may puncture the pericardium, and only wound the wall of the heart.

In most cases when a stab is not immediately fatal, an exploration of the wound is required. The wound is first examined by a probe and finger. If necessary, the wound in the chest is enlarged by turning up a flap. Blood may be gently washed out of the pleura, a free outflow being provided. A wound of the lung may be seized and sutured. The diaphragm may be sutured after replacing or ligaturing off the omentum. A wound of the stomach may be sutured through the pleura, or it may be necessary to open the peritoneum. Bleeding from the liver may be checked by a plug. Blood in the pericardium may be washed out, and the cavity drained, so as to prevent re-collection and pressure on the heart. It has even been possible to ligature a vessel on the beating heart. The wound is partly sutured; the rest is filled by a gauze strip. By this means exudation into the pleural cavity can escape, and also the air, so that no surgical emphysema occurs.

A bullet-wound not immediately fatal may go through the chest without doing much damage, or, on the other hand, set up profuse hæmoptysis. It is rarely that a bullet-wound requires active treatment. The wounds of entrance and exit are cleaned and dressed without being explored even by a probe. The formation of a hæmothorax may be valuable, checking hæmoptysis by compressing the lung. Hæmoptysis is treated expectantly; the patient is kept absolutely at rest, and given as little fluid to drink as possible. There are two methods of directly treating profuse hæmoptysis following a bullet-wound, viz., venesection to faintness, and opening of the pleura on the side of the wounded lung, supposing this is known, so as to bring about collapse of the lung. These are heroic measures, perhaps justifiable in extreme cases. If, however, the collection of blood compresses the lung and causes dyspnœa, the pleural cavity must be washed out by enlarging the wound. A secondary empyema may form in the pleura, following the hæmothorax, and require drainage.

When a lacerated wound widely opens the pleura, a collapse of the lung does not necessarily follow, except immediately around the wound. The lung, indeed, is often prolapsed into the wound, being driven out by cough, *i.e.*, by forcible expiration with the glottis closed.

The wound is cleaned of all foreign material, and the lung replaced. If the prolapsed portion has become engorged, the wound may have to be enlarged. Only when badly lacerated should the prolapsed portion be ligatured and cut off. The wound is then closed with a gauze drain into the most dependent part of the pleural cavity. If a lung is collapsed, it will soon re-expand when the wound is covered, provided that it is not prevented by a collection of fluid in the pleura.

Injuries not attended by Wounds.

Fracture of the ribs, fracture and dislocation of the sternum, or a crush sufficient to injure the lung or heart is generally fatal. Children may be crushed to death without fracture of ribs.

Fracture of the Ribs.

Practically, a fracture of a rib is always due to a blow or a crush. In old patients—especially lunatics—senile osteomalacia sets up such a fragility of bone that ribs may be fractured by coughing or whilst turning in bed. From a crush or blow, whether applied in an antero-posterior or in a lateral direction, the ribs give way just in front of their angles. It is generally in fatal accidents that fractures through the necks or separations of the cartilages are met with. In many cases of fracture of one or two ribs there is no displacement, and crepitus cannot be obtained. The signs are great pain on breathing, a tendency to yield on pressure, and a friction rub from the bruising of the parietal pleura. It is not, therefore, necessary to obtain crepitus before deciding as to a fracture. Severe and local pain after an injury is treated as if it were a fracture. Indeed, a linear fracture is often proved to have occurred by the callus which subsequently forms. The first rib is rarely fractured, except along with the clavicle. The cartilages are seldom fractured, but painful periostitis is often set up, especially when the cartilages are bent. In severe, mostly fatal, cases the ribs are driven into the lungs, heart, diaphragm, liver, or spleen.

Rest in bed on the back until the pain passes off, with local applications of belladonna or opium, and sedatives against cough, form the treatment which should be invariably adopted. Patients who get about suffer much pain, which is relieved to a certain extent by applying about three pieces of strapping, some 2 inches wide, round the chest. Displacement of ribs generally occurs in accidents which are quickly fatal, otherwise reduction through an open wound might be indicated.

Injuries of the Sternum.

A Compound Fracture takes place from direct violence, which may cause comminution. Necrosis has followed where antiseptics were not used.

Fracture and Dislocation.—Blows or crushes, short of being immediately fatal, cause fracture and dislocation between the manubrium and the gladiolus, the upper end of the latter overlapping the former.

The patient being placed on a hard bed, with a firm pillow under the shoulders, the head is drawn well back, so that the manubrium may be pulled on and the dislocation reduced. Failing this, trephining and elevation has to be done.

Depression of the Ensiform Cartilage.—The xiphoid cartilage may be depressed by continued pressure, such as by a shoemaker's last, or depression may follow upon rickets. Gastric disturbance is often complained of. Gastric trouble due to the pressure of the cartilage must be distinguished from the same symptoms referred to the depressed cartilage.

Granting that there is evidence as to the ensiform cartilage being the actual cause, it should be removed, the knife being kept close to the cartilage so as not to open the peritoneum.

Tumours of the Chest Wall.

A tumour of the chest wall is distinguished from one connected with the interior of the thorax by the absence of an expansile impulse on coughing, and by the presence of normal breath-sounds.

Tubercular Periostitis and Abscess occur in children or young adults who show other signs of tubercular disease, especially of empyema. The abscess may burst and form an ulcer or a sinus.

Incision, erasion, and removal of diseased rib is required. If it is continuous with an abscess cavity in the chest, a localized empyema, the intervening ribs and thickened parietal pleura should be cut away. Afterwards the cavity is dressed daily with gauze.

Syphilitic Periostitis and Gumma may be distinguished from tubercular periostitis by the history or other evidences of syphilis, and by its occurrence in adults. The success of antisyphilitic remedies will distinguish from sarcoma.

Chronic Abscess.—An abscess may follow pyæmia of any kind, and particularly after typhoid fever.

Fatty Tumour.—A fatty tumour grows from the subpleural fat, to which it remains attached by a pedicle between the ribs, and is difficult to distinguish from an abscess until cut into. Excision with ligature of the pedicle is required.

Malignant Growth.—Primary periosteal sarcoma, chondro- or osteo-sarcoma, may commence on a rib. A malignant growth has to be distinguished from syphilitic periostitis. Secondary growths affect especially the sternum.

Secondary growths being excluded, an incision to establish a diagnosis is made, the thorax is opened to one side of the growth, and if it is made out by digital examination that the growth is circumscribed, the whole thickness of the thoracic wall—including the tumour—is cut away, the vessels tied, and the skin sutured down, with a strip of gauze in the lowest part of the cavity.

Retrosternal Abscess is caused by necrosis of the sternum, syphilitic or traumatic in origin, by extension of septic inflammation from the neck; or it may be due to suppuration in the thymus gland or its remnants. Besides the signs of fever, there is local pain, dulness to percussion, and fluctuation to the sides of the sternum and in the root of the neck. The vascular sounds being normal, an acute course, along with the foregoing signs, will distinguish it from a slow-forming aneurysm. A retrosternal goitre or cyst will, however, form slowly without signs of fever, and cause venous congestion of the neck, but abnormal vascular sounds are absent.

The sternum is cautiously trephined, or the suprasternal notch deepened with a chisel; the cavity is wiped out and dressed with gauze.

Aspiration of a Pleural Effusion.

Paracentesis is done with a needle and syringe for diagnostic purposes, or by using an aspirating syringe attached to a bottle, in order to complete the diagnosis and to remove fluid from the chest. The puncture may be made in the centre of the supposed collection of fluid, or, if the whole chest is involved, then in the seventh interspace in the posterior axillary line. It is generally a question of distinguishing between serous fluid and pus. As serous fluid runs easily through the cannula, aspiration can fail only when the needle is not pushed far enough, or because it is pushed too far. This can be avoided by moving the point of the needle, which should be felt free in a cavity. The inner wall of the pleura may be pushed before a blunt needle, or when the needle is not driven in sharply. When the needle enters the wall of a loculus, and the point is felt to be held, it should be withdrawn a little, and be pushed in a different direction. The needle may be plunged into a mass of spongy fibrin. These failures of tapping are more likely to occur in the case of pus which is thicker than serous fluid. The needle will, however, generally bring back sufficient pus to be detected by the microscope.

Aspiration may serve to show the existence of a hydatid cyst in the lung or pleura by drawing off the characteristic fluid. It may reveal a new growth when the needle enters a mass presenting much greater resistance than normal lung.

Aspiration is used for the relief of acute pleurisy. It may have to be done more than once. An increase of white cells in the fluid—as shown by turbidity—indicates a tendency to empyema. This is especially marked in children, unless the pleurisy quickly subsides. A chronic pleuritic effusion may require repeated tappings, but whenever re-collection is rapid it becomes necessary to stop this by draining the pleura. A chronic pleurisy will tend to pass over to an empyema more quickly whenever there is a tubercular diathesis. Aspiration affords relief in pneumothorax by favouring re-expansion. If pus be found, a little may be drawn off so as to temporarily relieve breathing; but a free incision should follow at the earliest possible moment. The aspiration of pus should invariably be the sign for incision, the only exception being a patient dying of pulmonary phthisis.

Should hydatid fluid—viz., clear, uncoloured fluid, free from albumin—be unexpectedly met with, aspiration should be stopped at once, and a free incision and evacuation of the cyst be *immediately* made, for aspiration of hydatid cysts of the lung has been attended by fatal pulmonary œdema. Any delay to incise is therefore dangerous.

Aspiration of a hæmothorax may be required to relieve pressure on the lung, whether caused by an injury or by malignant disease. If suppuration threatens, an incision is made, and the blood-clot gently washed out.

Empyema—Incision of Pleural Cavity—Excision of Portions from One or More Ribs.

This treatment is required whenever pus is present, unless the patient be in the last stage of pulmonary phthisis. Generally the pus will have been found at a preliminary aspiration, but failing this, the signs of fluid in the chest, with fever, wasting, clubbed fingers, etc., will indicate the necessity for incision and a digital exploration of the pleura.

The empyema should always be drained at the earliest possible moment, for apart from the general effect on the patient, the lung will be prevented from expanding the longer it remains compressed, thus entailing a larger operation, and greater deformity of the chest wall, with less respiratory lung tissue.

The incision should be made on the seventh rib (Fig. 73), just below the angle of the scapula. This opens the pleural cavity just above the diaphragm, and at the most dependent point for drainage when the patient is in bed on his back. This one opening suffices, for practically in all cases there is no cavity below, the space between the diaphragm and pleura becoming obliterated up to the eighth rib. There is no need for a counter-opening in front. Even if the empyema seems loculated and tends to point in front, an opening at the point described, and the thrusting forwards of the finger or forceps, will open and drain the cavity.

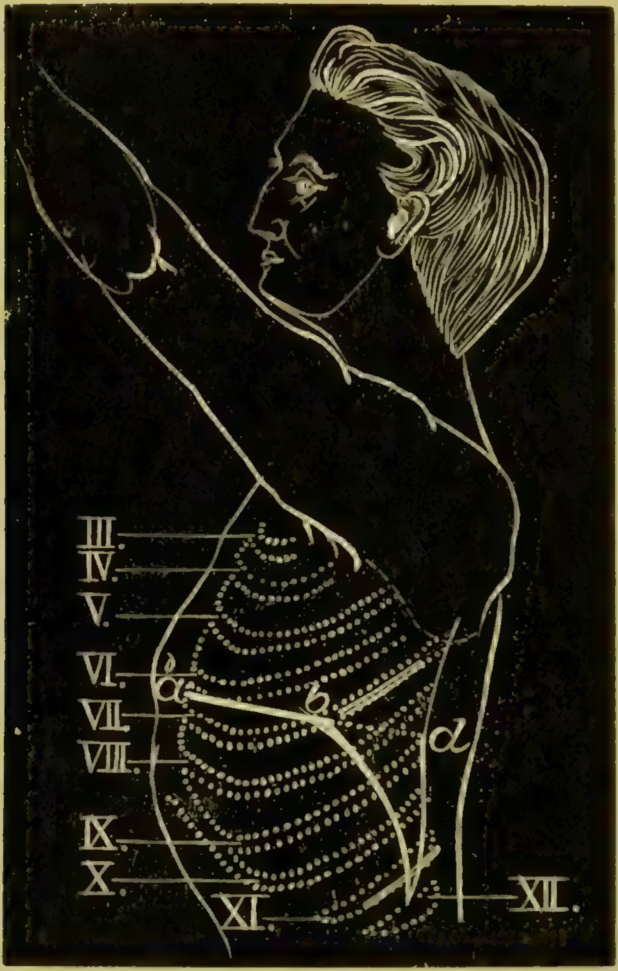


FIG. 73.—DIAGRAM OF THE CHEST WALL, THE RIBS BEING NUMBERED.

The line *a b d* marks the line of the diaphragm forming the lowest level of an empyema. The triangular space below *b d* is closed by adhesions between the diaphragm and the parietal pleura. The double line on the seventh rib is the usual incision for empyema, a lower one may wound the diaphragm. The double line on the eleventh rib marks the incision for transthoracic hepatotomy on the right side.

A piece of one rib—the seventh, some say the eighth—should be invariably resected. No harm is done, the operation is not a bit the more severe, and the patient none the worse.

The finger can then enter the pleural cavity, examine the interior, break down adhesions forming loculi, estimate the tendency to expansion on the part of the lung, and remove masses of fibrin and curdy pus, which otherwise would only keep up suppuration for a long time, whilst these masses were slowly breaking down. The wound is not closed by the ribs coming together, and the patient's recovery is not delayed by any retention of pus.

Operation.—The patient is superficially anæsthetized, with chloroform if a child, with gas and as little ether as possible for youths and adults. If very ill, no general anæsthetic is used; the skin may be frozen, or a little cocain injected. The patient is rolled as little as possible to the sound side, thus bringing the affected side over the edge of the table. The higher the operating table, the better. The seventh rib is felt in the posterior scapular line, and the incision, about 3 inches long, made at once down to the bone, so as to divide the periosteum. The wound being retracted, the periosteum is separated from the deep surface of the rib, and about 1½ inches excised.

The pleural wall is divided longitudinally in the seventh interspace, and forceps are pushed into the opening, so as to enlarge it and admit the finger. The pus is allowed to escape very slowly, so as not to excite cough. Masses of fibrin are hooked out, and small sponges on forceps may be used to wipe out the cavity. Hæmorrhage is usually checked by clamping and by pressure with sponges. An artery may require a ligature; if an intercostal cannot be easily picked up, a plug of wool may be pushed under the end of the rib so as to compress it. If a free opening is made, no drain need be inserted; but if small compared with the size of the cavity, a tube fitted with a flange must be inserted. Dressing is required twice or more daily; a tube, if one is used, is removed as soon as the discharge gets small, for organisms are introduced through it. The lung should expand and the chest wall sink in but little, so that the cavity is obliterated almost entirely by the expansion of the lung. There is no need to irrigate the pleura if there is free drainage; fatal results have occurred from excessive intrapleural pressure.

Complications.—The operation for empyema is surprisingly successful, seeing how ill the patients are at the time, always provided that such a free opening is made that from the date of the operation there is absolutely no retention of pus, and that the patient is not suffering from pulmonary phthisis. The only cases likely to be fatal are those in which the empyema is due to septic pneumonia, which is still unresolved at the operation. A death-rate from empyema of 50 per cent. or more, as formerly stated in books, implies the failure to resort to surgery in due time, or the incomplete evacuation through small openings, or the retention of a drainage-tube until a thick-walled sinus has formed.

The longer the delay in incising and completely draining an empyema, the more do adhesions prevent a re-expansion of the lung. Adhesions form early when the pleurisy is acute and the exudation fibrino-plastic. Conversely, when the effusion is serous, fixation of the lung may be long delayed, unless tuberculosis infiltrates the pleura.

Empyema of Long Standing—Empyematous Fistula—Thoracoplasty.

When a lung shows an impaired power of expansion, more ribs must be excised. The extent of the removal will depend upon the condition of the chest wall—whether it is still yielding, as in children and young women, or whether it has already become rigid. When it is found after the first operation that the lung does not readily expand, more of the chest wall is removed: 3 inches of the seventh rib, and some 2 inches of the sixth and eighth, should be excised. Thus the chest wall will fall in considerably.

An empyema which is not freely opened may burst into the lungs or on to the chest wall. There is a continuous discharge of pus, the lungs become more and more firmly fixed by adhesions, and the patient suffers from chronic septic absorption. The superficial fistulous tracks are laid open and scraped, with resection of ribs as required. Thickened parietal pleura is cut away. Whenever practicable, adhesions are broken down, so that the lung can be expanded during expiration.

The incision can be extended in the line of the ribs, or, where more room is required, a flap is turned up. The ribs can be removed from the neck up to the cartilage. Generally the thickened pleura can be cut away without important hæmorrhage. Ligatures may be applied, and the pleura cut away beyond, or the actual cautery may be used for cutting away vascular tissue. If adhesions can be broken down by the finger or blunt raspatory, marked expansion of the lung may be obtained; but this cannot be looked for when the condition has lasted a year or more. A large hole is made into the chest cavity, which is dressed frequently with gauze. The discharge is thus rapidly reduced in amount and becomes thin, whilst healthy vascular granulations line the cavity. The arrest of formation and absorption of pus allows the patient to regain strength. Meanwhile the chest wall falls in, and thus, by the combined effect of the formation of healthy fibrous tissue, the falling in of the chest wall, the expansion of the affected lung, and the bulging over of the healthy lung of the opposite side, an empyema of long standing may be cured. The life of a weak patient must not be endangered by a too-extensive operation, only part of the necessary removal is done at the first operation. The patient then gains strength, and a better idea can be formed as to what is required to close the cavity before the second operation. When healing is complete, there is a deformed side, but that is the inevitable result of the failure to incise an empyema early. A tendency to lateral curvature is combated by gymnastic exercises.

Hydatid of the Lung or Pleura.

When met with the cyst is incised, and the parasitic cyst removed. It is dangerous to aspirate, as pulmonary œdema and rapid death are likely to follow. If the lung expands after removal of the cyst, there is no further trouble. If the adventitious cyst prevents expansion, careful attempts should be made to break down the adhesions. In a late case the conditions are similar to empyema.

Abscess of the Lung—Bronchiectasis.

When the cavity has been localized by percussion and auscultation, the lung is exposed by a free incision. If there are no adhesions, the lung is seized with cyst forceps, drawn forwards, and fixed to the parietal pleura. A trocar and cannula is then plunged into the cavity, and the track dilated, so as to admit a drainage-tube. Iodoform powder may be insufflated, but the cavity must not be washed out or scraped.

Tubercular Cavity.

The foregoing treatment is applicable to a large chronic cavity. But success is doubtful even in such cases, and is hopeless when any extensive tubercular process is present.

Gangrene of the Lung.

The pleural cavity is freely opened and washed out. Where the gangrene is found limited to a lobe of the lung, the portion may be ligatured off or cut into with the cautery. Frequent irrigation with permanganate at a low pressure, with free drainage, offers the only hope.

The Pericardium.

The pericardium is aspirated to remove serous effusion, or incised and drained for empyema. The aspiration is done through the fifth or fourth space, close to the sternum, on the left side. For drainage a flap of skin may be turned up, and either or both the fourth and fifth rib cartilages excised. Behind them appears the internal mammary artery, about $\frac{2}{5}$-inch from the sternum, in front of the triangularis sterni muscle. The pleural fold appears behind the junction of the ribs with the cartilages; it is pinkish and translucent, with some fat along its edges. The pericardium is opaque, shiny, and white. By removing the sixth cartilage the abdomen may be opened, unless the pericardium has become distended downwards into the space between the xiphoid cartilage and the seventh rib cartilage. A drainage-tube is dispensed with by suturing the edges of the pericardium to the surface. An empyema of the pericardium may coexist with one of the pleura on the left side.

CHAPTER XXVII.

SURGERY OF THE BREAST.

THE subject deals with the female breast. However, the male breast, an organ of the female type which is not completely aborted, may be diseased in a similar fashion. The breast lies between two layers of the superficial fascia, whilst its under surface is separated by a loose connective-tissue space from the sheath or fascia covering the pectoral muscles. As life goes on, the superficial fascia enclosing the breast stretches, and the breast becomes more or less pendulous. The breast is examined by pressing it with the palm or surface of the hand and fingers against the chest wall, when, if normal, it will be found of a uniformly soft, diffluent texture. It is a mistake to raise the breast between the thumb and fingers, for the normal breast then feels of a hard texture, which may be mistaken for a diseased condition. Its margin is ill-defined. Lobules of breast tissue lie outside the apparent margin. Both the size and the extent of the breast varies with the amount of fat lying between the lobules. When there is much fat, the breast is large and widespread; and when there is little fat, the gland is much more circumscribed, so that it may appear but little larger than the male organ. The amount of fat, and therefore the size of the breast, is generally proportionate to the amount of subcutaneous fat. As an exception, however, a thin woman may have a large accumulation of fat in the breast. It is impossible beforehand to judge of the capacity of the breast to secrete milk.

Diseases of the breast are influenced largely by the changes which occur in the breast at birth, at puberty, during pregnancy and lactation, and after the climacteric. The minute structure of the breast, the cubical epithelium of the acini, the columnar epithelium of the ducts, the stratified epithelium of the nipple, the connective-tissue framework, and the superficial glands of the areola, all become the sites for the commencement of disease.

The arteries enter the breast from above—from the axillary artery to the upper and outer side, and to the upper and inner side from the perforating terminals of the intercostals. The veins take a reverse course, entering the axillary vein just in front of the corresponding arteries, so that when the axillary vein and the branches entering are exposed, the arteries may be found just behind. The lymphatics commence around the alveoli; some run along the ducts, anastomose at the nipple, pass outwards in the skin as far as the outer margin of the breast, and then dip down into the pectoral fascia; others pass out along the connective-tissue septa; others enter the pectoral fascia directly from the deeper parts of the breast. All the lymphatics are thus collected in the pectoral fascia, in which they course up to the axillary lymphatic glands. Some lymphatics from the inner side of the breast may follow the line of the perforating intercostal arteries to the glands of the anterior mediastinum, or even anastomose with those of the opposite side across the middle line. But this is an exceptional course for the extension of cancer in the early stages.

General sensation is especially well developed in the female breast, and any disease may give rise to pain. The nerves are connected with the spinal cord by cervical nerve-roots, and this explains why pain caused by disease of the breast may be referred down the arm. Pain is also felt in the arm when the intercosto-humeral nerve is involved by disease invading the axilla.

In sensitive or neurotic women there may be hyperæsthesia or pain, mastodynia, without any local cause.

The Breast at the Different Periods of Life.

In Infancy.—An infant, male or female, often has some swelling of each breast a few days after birth, accompanied by microscopical changes, simulating those occurring with lactation. A small discharge of milk, which may be blood-stained, or an actual inflammation, may follow. Suppuration with the formation of an abscess follows from septic infection —*e.g.*, when the mother has a mammary abscess. Both mother and infant may thus have an abscess in each breast simultaneously.

At Puberty the female breast undergoes active development, and alveoli form from the secondary ducts. The secretion of a milky fluid often occurs, and chronic inflammation may follow. The same may happen in the male.

During Menstruation the breast, in the case of some women, swells, and a serous or blood-stained discharge may occasionally escape from the nipple. With this the menstruation may be quite normal, or, on the other hand, scanty or painful.

Pregnancy and Lactation.—Lactation is a fruitful source of disease. Inflammation and abscess, retention cysts from obstruction of ducts or the commencement of tumours, may arise. When malignant disease commences during lactation, it is apt to be of very rapid growth.

Milk is naturally free from pathogenic germs. These, however, grow in the remains of milk not washed away after suckling, and then enter by the nipple and ducts, or by fissures made by the bites of the child.

After the Climacteric.—Atrophic changes occur in the breast at or following upon the climacteric, between the ages of thirty-five and fifty. Whether from slight injuries, or from retention in alveoli owing to atrophy of the ducts, chronic inflammation and tumours are much more likely to commence about this time.

In Old Age a slow-growing, more definitely localized, form of cancer begins without any apparent cause. The older the woman, the more marked the tendency both as to occurrence and as to slow growth and localization. Old age does not exclude, however, a malignant type of cancer.

Abnormalities of the Breast.

Depressed Nipples.—The condition indicates an imperfectly formed breast, with a greater liability to become diseased. Retention of milk occurs owing to imperfect patency of ducts, and chronic inflammations and malignant disease more often arise than in a well-formed breast. The folds of the depressed nipple are not easily kept free from sebaceous and epithelial debris. The child cannot seize the nipple and suck easily, and so it bites the nipple and causes fissures.

During pregnancy the woman should squeeze and pull out the nipple. She must take special care as to cleanliness, and never allow the child to suck longer than absolutely necessary. If inflammation threatens, the child is immediately taken from the affected breast, which is fomented and squeezed until all danger of retention of milk has passed. The nipple may be made to project better by excising a semilunar piece of skin from the breast above and below it.

Supernumerary Mammary Lobules and Nipples.—They are commonest between the outer margin of the breast and the axilla, but have been met with at a distance away on the abdomen; also at the back, and over the great trochanter, in places not to be explained by reference to animals. They may have a projecting nipple, or the ducts may open on the level surface of the skin. They may enlarge and secrete milk during lactation, and are subject to the same diseases as the breast. Retention cysts, abscess, or malignant disease may arise in them. In the axilla, enlarged tubular sweat-glands are distinguished from those showing breast tissue by means of the microscope. Supernumerary breast lobules and nipples should be excised to prevent disease.

Conditions of the Breast requiring Incision and Erasion.

Retention of Milk, causing Acute Inflammation.—This is nearly always connected with lactation. The inflammation may attack the lobules of the breast, or commence around the nipple, and secondarily spread to the organ. Acute inflammation in the substance of the breast is caused by the retention of milk, which decomposes owing to infection from without. Owing to the breast not being emptied by the child, certain secondary ducts become distended, and as further distension goes on, the more does a valvular obstruction ensue. After decomposition an abscess forms, the pus bursts through the wall of the duct, fuses with other abscesses in the centre of the breasts, or bursts into the subcutaneous tissue, or, less commonly, into the loose connective tissue underneath the breast. If allowed to burst through the skin, it may do so at more than one spot, and so several sinuses are left which discharge regularly or intermittently by an alternation of retention and discharge. Extreme cases occur in which the whole breast sloughs.

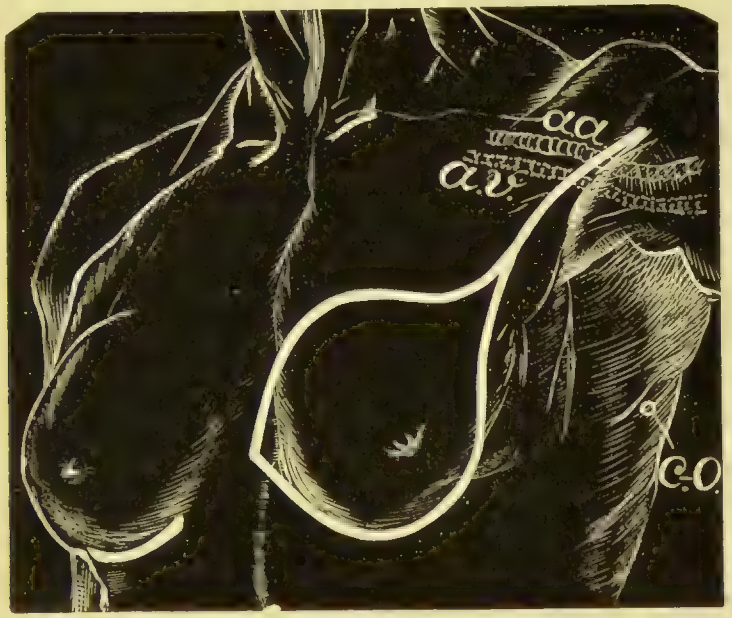


FIG. 74.—BREAST INCISIONS.

Right side: submammary incision for abscesses and benign tumours. Left side: racket-shaped incision for scirrhus carcinoma; *a v*, axillary vein; *a a*, axillary artery; *c-o*, counter-opening through the skin of the hinder and lower part of the axilla for the drainage-tube.

If the child does not empty the breast, this should be done by suction by the breast-pump, or by simply filling a soda-water bottle with hot water, pouring it off, and while the air is still hot inside applying the mouth of the bottle over the nipple: as the air cools suction will draw milk from the nipple. The secretion of milk ceases in a few days from a breast to which the child is not put and from which the milk is withdrawn. If it be wished to stop the formation of milk in both breasts, a few doses of iodide of potassium are given, and belladonna extract applied. If retention goes further, suction may not suffice. The milk must in this case be expressed. The breast is taken in the hollow of the two hands, and, very steadily, increasing pressure is applied. If very painful, nitrous oxide gas may be given. At first a little whey exudes, then a plug of curd, finally a stream of milk. The expression should be continued until the breast has become soft.

The woman continues this expression, combined with hot fomentations and the drug treatment as above. Pus may be squeezed out, and be distinguished by being not so easily absorbed as milk by cotton-wool.

When an abscess has formed, an early incision is made. The incision, wherever possible, is made horizontally in the fold below the breast, and the abscess opened by pushing in dressing forceps (Fig. 74). This is done for two reasons: one is that the opening is the most dependent, and the other that the scar is out of sight. The next best incision is a radial incision in one of the two lower quadrants.

Sinuses may have to be incised, scraped, and plugged with gauze daily until they fill up. A breast riddled with sinuses may have to be excised.

Areolar Abscess.—It arises in the areolar glands from lack of cleanliness, the nipple not being washed and dried after each lactation. The two conditions preceding an abscess may be eczema or fissures. Eczema may also arise from external irritation, such as the pressure of the stays, or owing to a discharge from the nipple. The fissures are produced by the eczema, or by the actual bite of the child. An areolar abscess, if not opened early, may cause a mammary abscess, either by first compressing the ducts and causing retention, or by direct extension.

Primary Abscesses not connected with lactation are usually preceded by congestion such as occurs in infancy, at puberty, or during menstruation.

Secondary Abscesses.—Various septic processes have been followed by a secondary abscess in the breast, such as typhoid fever, influenza, and pyæmia.

A Chronic Abscess may follow a blow or a cyst, or be a secondary abscess. It may be a breaking down of a tubercular or gummatous mass. It may form a smooth elastic tumour, so tense that fluctuation cannot be obtained. The existence of a chronic abscess cannot be definitely diagnosed except by puncture or incision.

Treatment.—Incision, erasion, and filling of the cavity daily with gauze.

Simple Cysts, Galactoceles.—An obstructed duct may give rise to retention in a secondary duct lobule, which then becomes dilated by milk. This does not decompose, and so no inflammation follows. The curd is precipitated, and thin whey fills the cyst.

The treatment is the same as for chronic abscess.

Conditions requiring Local Excision.

Chronic Mastitis.—It may follow a blow, or originate in connection with disturbances of menstruation or lactation. Attention is drawn by the pain to an induration of one or more lobules of the breast, as felt by pressure against the chest wall. Chronic mastitis is distinguished by consisting of hardened breast tissue from a circumscribed distinct swelling or tumour, and from a scirrhus cancer by the absence of the special signs of this disease.

The local inflammation is reduced by cold lotions, hot fomentations, and belladonna extract, which may be smeared on or applied as a plaster, a hole being cut in it for the nipple. The patient must not handle the swelling nor wear tight stays. Aperients and iodide of potassium may be administered internally. If relief does not follow, excision is done, not only because of the pain, but from the liability to go on to malignant disease. Chronic mastitis is recognised by the whitish appearance on section, only differing from the rest of the breast by its hardness. There is no capsule.

Fibro-adenoma.—As distinguished from chronic mastitis, adenoma forms an encapsuled tumour, frequently at the outer periphery of the breast, connected to it only by a pedicle. It is seen in young women up to thirty. The common type is composed of fibrous tissue, with some glandular alveoli which are dilated into small cysts. Less commonly, the tumour is wholly fibrous, or, on the other hand, mainly cystic. Such a tumour may develop rapidly, and prove to be a fibro-cystic sarcoma, or become the origin of carcinoma, the malignant growth in the one case being in the connective-tissue elements, in the latter in the glandular.

Other rarer tumours similarly treated are lipomas, erectile or nævoid tumours, enchondromas, etc.; but these can scarcely be diagnosed before the incision.

Method of Local Removal of a Tumour.—Wherever possible, a semilunar incision is made in the fold below the breast, the breast retracted upwards, and the tumour shelled out or cut out from beneath. This method avoids a visible scar, and there is no pocket for the collection of discharges. Failing this the incision should be radial (Fig. 74).

Conditions requiring Excision of the Whole Breast, but not—at least, in the Early Stages—of the Pectoral Fascia, nor of the Axillary Glands.

New Growths are frequent in the female breast; 15 per cent. of all neoplasms in the female occur in this organ. The majority arise from the gland substance. Of one hundred cases of cancer, ninety were found to be connected with the acini, six with the ducts, and three with the nipple, eighty-six of the ninety being classed as scirrhus.

New growths certainly follow inflammation and injury in some cases, but in many there is absolutely no reason to assume these causes. In some cases scirrhus appears to follow the atrophic changes in the breast after the climacteric has passed, and the slow-growing scirrhus of old women specially illustrates this connection. The rarity, however, with which malignant disease appears in the male breast, forming no more than 1 per cent. of the total neoplasms in the male, does not support the notion that cancer tends to arise in atrophic structures. Malignant disease arises sometimes in a breast during lactation, but it cannot be supposed that there is more in lactation than a stimulus to a rapid growth from the increased vascularity.

Micro-organisms have been assumed as the cause, and the squamous-celled epithelioma of the nipple, following upon long-continued eczema, affords a suggestive instance; but this hypothesis remains unproved.

Upon incision, a tumour involving the whole breast may be distinguished from one localized in a portion only by the absence of encapsulation and of healthy mammary tissue around. When the nipple and terminations of the ducts are involved, the whole breast should be taken away, even though it be healthy.

Before proceeding to excision of the breast, an incision must always be made into the tumour. This is an invariable rule, however certain the diagnosis beforehand.

Hypertrophy of the Whole Breast.—It has been mentioned that breasts vary in size according to the amount of fat. A thin, ill-nourished, anæmic woman may suffer from a gradual increase of fat in the breast, owing to venous congestion. Occasionally, soon after puberty, a breast may enlarge to an enormous size, the overgrowth consisting of an excess of fibrous tissue. The mass is in a state of venous congestion, and ulceration of the surface from this cause ensues.

It may be possible to arrest the enlargement by suspending the breast in a sling, by reducing the inflammation, and by improving the patient's general health. If this treatment fails, excision will be required.

Multilocular Cystic Tumours—Cystic Disease of the Breast.—The normal breast tissue becomes altered by the growth of new fibrous tissue, interspersed with cysts containing fluid, and varying in size from a walnut to a pin's head. The section appears like a honeycomb, and involves the whole breast. It may be bilateral. If not treated, it becomes gradually more and more clearly sarcomatous, involving the skin and glands in the axilla.

The treatment consists of early excision of the whole breast.

Malignant Sarcomas.—Sarcomas of malignant type are less common by far than scirrhous cancer, and generally grow in younger women. The growth may vary in texture from a fibro-sarcoma to a medullary or brain-like mass, which grows with great rapidity. Cysts may form by the breaking down of the tumour, and then contain extravasated blood and cell debris. The tumour is not encapsuled, except when very small. The tumour may fungate through the skin, but the skin is not infiltrated. Sarcoma of the breast causes an enlargement of the glands in the axilla in its later stages.

A free removal of the breast at the earliest possible moment is required. If allowed to progress, the removal of the pectoral fascia and axillary glands may be indicated; but generally, if the delay has been so long, the growth has already become disseminated.

From sarcoma must be distinguished rare cases of lymphadenoma occurring in both breasts, and causing enlargement of the axillary and supraclavicular glands, for such are amenable to the administration of large doses of arsenic.

Duct Papillomas.—A papillary outgrowth of columnar epithelium, covering a stem of fibrous tissue, arises in a duct near the nipple. The duct is distended by the cauliflower growth, which is only attached to the wall at one point. The papilloma may fungate through the opening of the duct, and appear on the nipple, or simply cause a tumour under the nipple by distending a duct.

Duct Cancer.—An extension of the papillary outgrowth may take place through the wall of the duct, so that columnar cells invade the breast tissue. It continues to grow slowly, and it may be a year or two before the axillary glands are enlarged.

The special sign of duct papilloma and cancer is a continuous or intermittent blood-stained discharge from the nipple, the nipple being free from eczema.

Simple removal of the breast for duct cancer is attended by cure. Even when the axillary glands are enlarged, the result of complete excision has been uniformly good.

Tubercular Disease of the Breast.—This is a rare condition in the human female. It can only be diagnosed beforehand by other evidences of tubercular disease in the patient. It is common in cows, following inflammation during lactation, but the cases which have occurred in women have by no means been generally connected with lactation.

Syphilitic Disease of the Breast.—A gumma may simulate a chronic inflammation, a cold abscess, or a tumour of the breast. The skin of the breast may also be involved by gummatous nodules or ulcers. Other signs of syphilis may suggest the trial of antisyphilitic remedies.

Excision of the Breast and of the Lymphatics and Lymphatic Glands in the Axilla.

This is required for two conditions: carcinoma of the breast and epithelioma of the nipple.

Carcinoma of the Breast.—The commonest type is known as scirrhus mammæ. A tumour can be felt when the breast is pressed back against the thoracic wall, having an ill-defined outline, and which is more or less closely attached to the nipple. The nipple is retracted; even if it has never been prominent, yet the depression will become more marked. The tumour early fixes the skin, which becomes puckered over it, and beneath it gradually becomes more adherent to the pectoral muscle. It is not painful like an inflammation. but there are sharp, irregular shooting pains, and a commencing tenderness of the axillary glands. In a more advanced case, the tumour is adherent both to the skin and to the pectoral fascia, and the axillary glands are enlarged and hard. On incision, the knife cuts with a grating noise, and the section resembles that of an unripe pear.

At the earliest stages, a scirrhus mammæ is like a chronic mastitis; but the latter occurs in a younger woman, with more pain in the early stages, commencing after a blow or in connection with suckling. The nipple is not retracted, and the tumour is more peripheral in position.

The enlarged axillary glands in connection with a tumour can hardly be mistaken, except in the very rare condition of lymphadenoma or of tubercle. A tendency of the axillary glands to inflame and suppurate subsequent to a tumour is rather in favour of a rapidly growing scirrhus. Less often the tumour is soft, brain-like, growing very rapidly, or is cystic, either multilocular, containing broken-down blood-clot, or a single cyst with a thin wall, but which is closely adherent to surrounding structures as distinct from a simple cyst; or the tumour has undergone colloid degeneration, resembling the brownish colour of a section of the thyroid gland. The treatment is the same for all cases.

Epithelioma of the Nipple.—This is a much less common condition than scirrhus. It may be preceded by an eczema. The epithelioma may be of the ulcerative type, forming an indurated ulcer, or be papillary, having a zone of induration around it. The axillary glands become infected early.

A hard, syphilitic sore forming on the nipple is quickly followed by enlargement of the axillary glands and a rash. A vaccine pustule may form in a mother whose suckling child has been vaccinated. The pustule will be characteristic, and cause enlargement of the axillary glands, but begin to subside after the eighth day.

The Operation (Fig. 74).—The patient's corresponding arm is held extended by an assistant, or may be folded under her head, so that the back of her head rests on the flexor aspect of the forearm, in which position the anæsthetist can aid in maintaining it. A cut is made into the tumour to confirm the diagnosis. Then, with a large knife, the incision is made from the outer edge of the sternum, arching over the upper border of the breast, across the pectoral muscle, and along the lower border of its tendon as far as its insertion into the humerus. The upper margin of the incision is retracted upwards, the breast being drawn down. According to the extent of the disease, an upper skin flap must be made by retracting and undermining.

The retraction and undermining has two ends in view: one in order to get beyond the extreme border of the breast, of its outlying lobules, and of the infiltrated pectoral fascia; and, secondly, the skin is rendered far more extensile. The incision is next deepened down into the muscular substance. By retracting the muscle upwards, and the axillary fat downwards, the axillary vein is exposed. Its larger branches are divided between two clamps; an artery lies behind each vein, and may be clamped with it or separately. This method follows the normal rule of surgery in exposing and clamping the vessels as the first stage of an excision.

A curved incision is next made below the breast, then raising and undermining the skin. This is carried down to the pectoral muscle, and to the latissimus dorsi, and to the chest wall between. The whole mass is cut away from within outwards, including the superficial fibres of the pectoral muscle, so as to leave none of the aponeurosis nor the lymphatics running in or just beneath it. The more adherent the growth to the chest wall, the greater the care needed to separate it from the surface of the intercostal muscles, which, in the wide spaces between the ribs, may be blown out during forcible expiration, and so the pleura be opened. The whole contents of the axilla should be removed with the breast from the subscapularis and latissimus dorsi muscles, the preliminary clamping of the vessels making this easy. The removal of the breast and glands in one strip is best; if removed piecemeal, portions may be overlooked, or bits of the cancer may perhaps be scattered in the wound and reinoculate it. After arresting hæmorrhage and washing away all fragments, the wound is sewn up. When the edges come together easily, a continuous suture is used. A drain is inserted through a counter-opening made behind into the most dependent part of the axilla when the patient is lying down. There is no need for drains in the thoracic wound, as firm pressure can be applied. One in the axilla prevents accumulation of exudation. The drain inserted as described does not interfere with the wound, and, being removed at the first dressing, the buttonhole heals as soon as the operation wound.

Difficulties in connection with the Union of the Wound.—When the skin around a tumour of the breast is raised from its attachments, it becomes very much more extensile. The skin can be raised as high as the clavicle, or over that bone, so as to stretch the skin of the neck, on the inner side also from the sternum; but the major part of the free skin is obtained from the lower ribs and from behind about the angle of the scapula. No important bleeding occurs, and a large wound may in this way be brought together.

Interrupted silver wire sutures are used where the tension is greatest. In addition, the application of strapping (see Fig. 18, p. 22) will keep the edges of the wound approximated. If any gaping occurs, the granulating surface is covered in by epidermal grafts, which are, however, apt to fail when applied to a freshly-cut surface. Supposing that a wound cannot be brought together by undermining the skin alone, then this can be combined with transplantation of a flap, or the edges are left apart, and the granulating surface grafted later.

For advanced cases the following measures have been proposed: Complete removal of the pectoralis major and minor muscles; division of the clavicle, and removal of the supraclavicular glands, in addition to the axillary; amputation of the arm, employing a flap from the shoulder to cover in the large surface left by removal of the breast. Ligature of the axillary vein, and excision of a portion involved, may be successfully done, especially if the growth has already compressed the vein and favoured anastomosis. Ligature of the artery, in addition to excision of the vein, would render gangrene of the arm so likely as to be more dangerous than amputation. The objection to these extreme measures are that there is some risk of a fatal issue, and yet no certainty that relief will be of very long duration, to say nothing of cure.

Recurrence after Operation.

A growth in the line of the scar or in the axilla must be held to show that the primary operation was not sufficiently extensive. A second and wider removal should be done.

The cancer may reappear in the other breast, some internal organ, or in the bones, having the structure of mammary carcinoma, without any recurrence at the site of operation. Unfortunately, this recurrence may appear long after three years from the operation. Removal of all secondary growths should be done so long as the liver and lungs are apparently free. An eczema, inflammation, induration, or even ulceration, may appear in the scar, and yet healing afterwards take place, in spite even of the diagnosis of recurrence by microscopic examination. The few successes claimed for quack remedies have arisen from this difficulty in diagnosis in exceptional cases.

Palliative Treatment of Malignant Disease.

It is the primary growth—especially when it fungates—which causes the worst pain. Therefore, this should always be removed whenever the patient will submit, and the knife is the best agent for removal. Part of the growth may be cut away, and a caustic paste applied. After the separation of the sloughs, the wound is cup-shaped. It should not be allowed to fungate again. Whenever it tends to do so, caustics are applied, or the actual cautery. If a granulating surface free from sloughs is obtained, epidermal grafts may be applied, and may cover in the granulations, although they are malignant. When the glandular enlargement spreads from the axillary glands to those of the neck, the arm begins to swell, owing to solid œdema. At the first sign of this, the arm is kept well elevated on a pillow, and frequently massaged towards the trunk. If neglected and allowed to hang down, great pain is caused, the skin becomes brawny, lymph vesicles form and rupture, lymph exudes, dries and sets up eczema. The arm is to be then treated by arm baths, using water as hot as can be borne. When out of the water, the limb is carefully bandaged and kept raised. These measures will reduce the swelling, and anastomosing and lymph channels may open up. If extreme lymphatic obstruction and eczema are attended by pain, amputation may be done. But this measure will not relieve pain if it be due to pressure on the nerves of the brachial plexus.

Opium and morphine form the remedies for pain, and granted that the cancer is beyond any chance of being cured, there is no reason why they should not be used freely. Death may occur from exhaustion, or from secondary growths in the liver and lungs. Before this, secondary growths may occur in the bones, and cause spontaneous fractures.

CHAPTER XXVIII.

SURGERY OF THE ABDOMEN.

Abdominal surgery owes its peculiarities not only to the special affections of the viscera, but also from the fact that they are enclosed by the abdominal wall and by the peritoneum. The abdominal wall covers the viscera from sight and from direct touch. Observations, therefore, as to the altered shape of the abdomen, or as to the pathological conditions to be felt through the abdominal wall, are very uncertain. It is only when the peritoneal cavity has been laid open that a diagnosis can be made with any approach to exactness.

The peritoneum resembles the skin in covering and in affording a partial protection to the viscera. But it differs from skin in being affected like other serous membranes, and in having great powers of absorption. It allows of the rapid passage into the blood-stream of virulently septic poisons, but at the same time it as rapidly removes simple exudations so as to favour healing.

Abdominal symptoms are often uncertain evidence as to the actual disease. More than one cause produces the same disturbance in the functions of an organ. Special abdominal symptoms, such as vomiting, are not peculiar to any one disease or to any one organ.

Abdominal Symptoms.

Pain.—Pain may be local, felt by the patient, and increased by pressure on the organ involved. Pain and hyperæsthesia may be superficial, the pain being referred to the skin area, which has nerves from the same level of the spinal cord as that of the nerves belonging to the organ involved. General abdominal pain is referred to the front of the abdomen, with the umbilicus as a centre. Pain may be at first localized, and then later become severe and generalized, or *vice versâ*.

With the increase of pain there is a greater tension of the muscles of the abdominal wall. The most marked instance occurs in peritonitis without intestinal distension, when the abdominal wall is retracted and the muscles absolutely rigid.

Vomiting.—Vomiting is essentially a reversal of peristaltic movement. The vomit consists—

(*a*) Of the contents of the stomach, of undigested food; it may smell of alcohol or other substance; be frothy and contain sarcinæ; have a diminished amount of hydrochloric acid, and an excess of lactic acid; or contain blood arising from a simple ulcer in a young anæmic woman, or from malignant disease in an older patient. Vomit of such a kind points to the stomach as the seat of the disturbance. Regurgitation from the œsophagus is free from hydrochloric acid.

(*b*) Bile-stained vomit, *i.e.*, the contents of the duodenum. Vomit of this kind indicates that the intestines are involved. When obstruction, rupture, or perforation affects the duodenum, the vomit may never go beyond the biliary stage.

(*c*) Fæcal vomit. In recent and acute obstruction, the first vomit may be of the contents of the stomach, or be merely bile-stained, but it will shortly have a fæcal odour. It is a return of the liquid contents of the jejunum, not true fæces. One fæcal vomit along with other signs of acute internal obstruction or hernia is an imperative call for immediate relief.

The converse is not true, that intestinal obstruction is invariably accompanied by fæcal vomiting. There may be merely nausea, return of the contents of the stomach on taking food, or the vomiting may be intermittent and bile-stained without ever having a fæcal odour. This is likely to be the case in gradual and incomplete obstruction of the small intestines, or when the large intestines only are involved.

Vomiting of true fæces is rare. It has occurred in cases of imperforate anus, also in hysterical women. The latter have vomited enemata ten minutes after their introduction.

The Tongue.—The tongue is a mirror both for the intestinal canal and for the state of the peritoneum. It rapidly becomes dry, brown, and covered by a thick fur in intestinal obstruction. Whenever peritonitis is beginning, the tongue rapidly shrinks, becomes dry, brown, and fissured.

Collapse.—Collapse is especially due to the fall of general blood-pressure, consequent upon the collection of an excess of blood in the abdominal veins. Collapse may follow on a blow, or on the development of a hernia—internal or external—or other cause of intestinal obstruction, to be followed by vomiting and intestinal distension. Collapse also appears with perforation, air escapes into the peritoneal cavity, and the liver dulness is lost, etc.

The Fæces.—The motions may be altered in size, indicating that they have passed through a restricted lumen, be more or less fluid, or there is absolute constipation. Partial obstruction may be followed by diarrhœa, or diarrhœa intermits with constipation. There may be one motion or more after the onset of complete obstruction, from emptying of the bowel below. Mucus, dark-coloured blood, or pus may be mixed with the fæces or separately discharged. Bile may be absent, the fæces stinking, and fat be found in pancreatic disease without or with jaundice. Jaundice localizes the condition to the liver, gall-bladder, and gall-duct.

The Urine is scanty and high-coloured in intestinal affections attended by vomiting.

Tympanites.—Distension of the intestines by gas is always an unfavourable condition. From the fermentation which produces the gas are derived products which, on being absorbed, cause headache, malaise, loss of appetite, quicken the pulse, and render the patient liable to collapse. During an operation, tympanites causes great difficulty in manipulating the intestines. After an operation, if the distension continues, and is not quickly relieved by a purge, peritonitis, collapse, and death, soon follow.

Temperature.—Elevation of temperature cannot be considered by itself. In fatal peritonitis the temperature may not rise above 100° F., or if higher it descends as the condition of the patient becomes more grave. It may be subnormal after injury or perforation. It may rise a little after an operation, unaccompanied by other important symptoms, and return to the normal when the bowels are opened. As in other parts of the body, a steadily-rising temperature indicates suppuration.

The Pulse.—The rate and tension of the pulse is of great importance in all cases of obscure intestinal obstruction. When the pulse rises to 100° or 120°, an operation for the relief of the obstruction becomes urgent. After an operation a rapid pulse simply means shock, which, as the patient recovers, diminishes in rate to the normal. If, however, the pulse, after an operation, begins to rise above 100°, accompanied by tympanites, pain, etc., peritonitis threatens, which may be cut short by the bowels being freely opened.

Special Preparation of the Patient for an Abdominal Operation.

Thorough evacuation of the bowels must, if possible, be obtained, and if there has been chronic constipation, a short course of free purging may be necessary.

The bladder must always be emptied, whether spontaneously, or, when the operation is in the neighbourhood of the bladder, a catheter is passed just beforehand by the surgeon or nurse. If the urine be foul, the bladder must be washed out.

In all operations about the rectum, an enema is required, and the nurse must see that it is returned. The rectum may require to be regularly washed out, but this will often have to be postponed until the patient is anæsthetized. The vagina should be douched for several days before operations on the internal genital organs. A vaginal speculum may be passed, and all the folds wiped out with a sponge wrung out of 1 in 1,000 perchloride of mercury. This is followed by a plug of iodoform gauze. The stomach is washed out beforehand, when the opening of that viscus is contemplated ; it may also be done in order to examine the contents, to prevent fæcal vomiting whilst under the anæsthetic, or to see whether relief will follow the emptying of the stomach. But it is a manipulation which exhausts a patient.

The limbs of the patient are well wrapped up, and other precautions taken against cooling during a prolonged operation, such as the maintenance of the operating room at a temperature of 68° F. or more, and by applying hot-water bottles to the sides of the chest.

Abdominal Incisions and Sutures (Fig. 75).

The median vertical incision gives the largest amount of room for the exploration of the abdominal cavity and for the removal of tumours. It is made above the umbilicus to expose the stomach, liver, etc., and below the umbilicus for the pelvic organs. The incision is made just to one or other side of the linea alba, so as to divide the sheath of the rectus the whole length of the wound. Then the fibres of the rectus are separated—not cut—and retracted. The small vessels are clamped for five minutes, or twisted or compressed by the retractors. When bleeding has been arrested, the fascia and fat in front of the peritoneum are separated by forceps, and the peritoneum picked up and incised. The wound is generally enlarged by scissors, whilst the fingers of the left hand protect the abdominal contents.

Vertical incisions can also be made in the linea semilunaris, but are attended by much more bleeding, especially in the lower half of the abdomen, where the deep epigastric artery requires a ligature. Oblique incisions are used in the lumbar region to expose the kidney or to open a psoas abscess; also in the inguinal region, in order to ligature the iliac arteries outside the peritoneum and to expose the cæcum, appendix, or sigmoid flexure. Transverse incisions are occasionally used as adjuncts to vertical incisions, *e.g.*, in removing large kidney tumours or in suprapubic cystotomy.

Suture of the Abdominal Incision.—Deep sutures are inserted not more than ½ inch apart through all the layers, peritoneum, muscle, and skin, and are tightly knotted, after which superficial ones are inserted between. Strong silk, wire, or fishing gut are used for the deep sutures. The deep sutures are kept in as long as possible up to three weeks, and a well-fitting belt is applied before the patient sits up. The belt must be continuously worn, the bowels kept regular, and the patient should not put on much fat, or a hernia at the scar is very likely. It is important to include no more than just the edge of the peritoneum, then all three layers will be brought separately into contact. The incision may be united in stages by continuous sutures, peri-

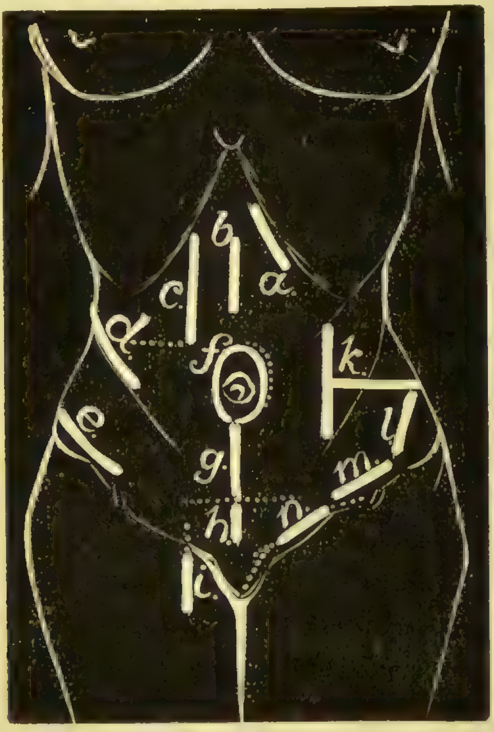


Fig. 75.—Lines of Abdominal Incisions.

a, Gastrostomy incision just below the costal margins, when the stomach is small; *b*, epigastric incision, extended upwards to the xiphoid cartilage and downwards to the umbilicus, for gastric operations in general; *c*, incision for gall-bladder and liver operations, extended outwards transversely in the dotted line; *d*, oblique lumbar incision for nephrotomy, extended forwards and downwards for the ureter; *k*, ⊤-shaped lumbar incision for the removal of a large kidney tumour; *e*, oblique incision for the cæcum and appendix, also for ligature of the iliac arteries outside the peritoneum; *f*, oval incision for umbilical hernia; *g*, general abdominal incision, extended down to the pubes and upwards to or above the umbilicus; *h*, supra-pubic cystotomy, increased downwards to the pubes or transversely in the dotted line; *i*, incision for femoral hernia, increased up to or above Poupart's ligament by the dotted line; *l*, incision for inguinal colotomy (colostomy); *m*, incision over the internal abdominal ring for inguinal hernia; *n*, incision for varicocele, castration, etc., which can be extended upwards and downwards in the dotted line.

toneum to peritoneum, muscle to muscle, skin to skin. A continuous suture may be used for the peritoneum, and interrupted sutures for the skin and muscle together.

Abdominal Manipulations.

The incision into the peritoneal cavity should be small in doubtful cases until an examination has been made with the finger.

Free serous fluid may be found in cases of cirrhosis of the liver, or in disseminated cancer. The cavity is washed out and drained for a few days whenever a previous tapping has been followed by reaccumulation of the fluid.

In the ascitic form of tuberculous peritonitis, washing out and immediate closure is successful. In other cases of purulent peritonitis, drainage is required in addition.

Limited pockets containing pus may be sponged out, the sponge having been wrung out of 5 per cent. carbolic acid, but without allowing any of the antiseptic to escape. Adhesions are treated with differing degrees of force. When between a tumour and the abdominal wall or pelvis, separation is done by the fingers, using moderate force. Firm adhesions to healthy intestines are divided by cutting, keeping well away from the intestinal wall, *e.g.*, leaving a piece of the cyst or tumour attached, and afterwards shaving it down. In the adhesive form of tubercular peritonitis, the intestines tear like wet paper, and the operation should not extend beyond the exploratory incision. Malignant adhesions are very friable, and should also be left alone whenever complete excision cannot be done. Adhesions constricting loops of the intestines are divided. When the bowel is likely to give way, it must be first clamped above and below to avoid the extravasation of fæces.

Whenever the operation is a local one and the rest of the peritoneum healthy, the first care of the surgeon on opening the peritoneum is to isolate the field of operation. This may be done by dragging the affected part outside and surrounding it with sponges and gauze whilst the operation is carried out. The part is washed thoroughly before returning.

When it is impossible to draw the part outside, the rest of the peritoneum is shut off by flat sponges or gauze. Each sponge so inserted must be marked by counting, or by attaching to it a piece of silk, or clamp forceps. In special cases the omentum may be so fixed by sutures as to shut off the cavity. Or it may be decided to do the operation on two occasions, the first being directed to get peritoneal adhesions around, so as to shut off the part from the rest of the peritoneal cavity.

Abdominal Hæmorrhage.

Wherever possible, a ligature is applied to vessels before division, the pedicle ligature for all thick masses, a simple ligature for adhesions. The search for a wounded vessel requires a good light, a free abdominal incision, and the retraction of the intestines. The bleeding surfaces left by the separation of adhesions may be treated by applying hot sponge pressure, by drawing the edges of the surface together with suture, or by plugging with a strip of gauze, the end of which is brought outside. If the actual cautery be used, it should be at a dull red heat, so as to sear, *i.e.*, to simply desiccate the tissues rather than to char them.

Abdominal Irrigation.

This is employed when the peritoneal cavity has been widely involved beforehand, or becomes so during an operation. Then water at blood heat is poured in from an irrigator or from jugs, until all returns quite clear. No antiseptic is employed. Sponges are wrung dry from the antiseptic fluid lest any should be carried over. When only locally soiled, sponging suffices, but it is not wise to sponge the intestines too much.

Drainage of the Abdomen.

Drainage is unnecessary except for septic inflammation, where exudation or hæmorrhage is expected, or where free fluid present before the operation indicates a diminished readiness to absorb. Instead of a tube, strips of gauze are used. The tube or the gauze reaches into the pelvis, and is withdrawn in a day or two. Cavities behind the peritoneum, such as may be left after nephrectomy, are better drained. The same holds good whenever the peritoneum has been extensively damaged.

After an Abdominal Operation.

The patient must not sit up, or be exposed to any strain of the abdomen, until the wall has firmly healed. Nothing is given by the mouth to strong adults for twenty-four hours except sips of hot water. If the patient is weak, nutrient enemata or suppositories are used after consciousness has been regained. Children require sips of milk every half-hour after the recovery of consciousness. For flatus, drops of cajeput oil on sugar, or teaspoonfuls of brandy-and-water or peppermint, may be occasionally given. During the second day about a pint of fluid food is taken. The bowels should move on the third day, or, if tympanites appear, then on the second, in order to avoid the increased tendency to peritonitis consequent on the distension. Any mild aperient, such as seidlitz powder. compound liquorice powder, calomel, etc., may be employed, supplemented by the passage of a rectal tube, a glycerin enema or suppository, or a soap-and-water enema. The bed-pan must be introduced without straining the abdominal wall. The urine may have to be drawn off for some days. After the bowels have moved, the diet is gradually increased, yet so as not to cause pain or nausea.

The dressing need not be changed for a week or ten days, except when a tube has been inserted, when frequent dressings, and the aspiration of fluid from the tube, will be necessary.

Puncture or Aspiration.

Puncture or aspiration should be employed only in the case of ascites. It should not be employed for diagnosis, for it is not only unsatisfactory as to the positive evidence it affords, but there is danger from leakage into the peritoneum from an ovarian cyst, etc., and removal is thereby rendered more difficult.

More dangerous still is the aspiration of distended intestines. Although the trocar may be aseptic when plunged in, it brings back, when withdrawn, germs which infect the abdominal wall and peritoneum. A short incision is safer by far than puncture; it allows of digital exploration, and can be closed by one or two deep sutures.

In order to tap an ascitic patient, a large ascites trocar is taken, a nick made through the skin, and the trocar plunged sharply in for at least half its length, and in a fat man up to the hilt. The fluid is let off slowly. A rubber catheter may be slipped through the cannula, and the free end connected with a basin containing antiseptic fluid.

If the abdomen refills, an incision is always safer, for the omentum may have stuck to the wall at the site of the puncture, and then a second puncture may prick a large vein.

The Abdominal Wall.

Wound.—A lacerated wound divides more or less all the structures of the abdominal wall down to the peritoneal cavity, and if it enters that cavity hernia of a viscus may occur. The prolapsed viscus is cleansed, returned, and the wall sutured, as after operation, a drain being placed in the pelvis.

Rupture.—Rupture of the wall has occurred to a patient whose abdomen was much distended by ascitic fluid. The coverings of a hernia may rupture. The muscular parietes may rupture, but not the skin, forming a traumatic hernia, covered by skin and peritoneum. The rectus abdominis may be ruptured in labour, in vomiting, during tetanic spasms, or from any unaccustomed exertion, such as the attempt to vault on a horse. A hæmatoma forming at the site of the ruptured muscle may suppurate or become a cyst.

Abscess.—An abscess follows an injury, or is connected with perityphlitis, parametritis, disease of bone, etc.; it may burst into the peritoneal cavity or externally.

Ventral hernia may occur in the scar left after an abscess or an operation. It is avoided by applying a restraining apparatus before getting out of bed. A cure may be attempted by excising the stretched scar, suturing the wall by stages, and using an abdominal belt for a lengthy period.

Tumours.—Lipomas grow from the subperitoneal layer protruding between the muscular fibres, and connected with its source by a pedicle. Excision is done without opening the peritoneal cavity.

A **Fibroma** or **Sarcoma** may form a tumour suitable for removal. A sarcoma grew in the rectus, for which the whole muscle from the sternum to the pubes was removed. A gumma will be distinguished by the success of antisyphilitic remedies and other signs. Epithelioma may occur in the scar of an abdominal wound, preceded by eczema, or malignant disease extends to the scar from some internal tumour.

The Umbilicus.

The umbilicus is a natural scar, and occasionally is the seat of disease.

Inflammation.—Inflammation appears in infants owing to neglect after ligature of the cord. Both in children and adults retention of dirt and epidermal débris set up eczema and a foul discharge. The most persistent cases are venereal in origin, mucous tubercles, condylomata. Pockets containing pus are apt to form. If induration persists, the question of malignant disease arises. Mercurial ointment and lotion are first applied locally, and mercury is given internally in resistant cases. If this treatment fails, and especially where there are pockets containing pus or much induration, the umbilicus and the surrounding tissue are removed by a circular incision ; great care must be taken not to open the peritoneum. The wound is filled with gauze until it heals from the bottom.

Urinary Fistula.—A patent urachus may be present in an infant, from which urine escapes during micturition and when crying and coughing. If there is no urinary obstruction, spontaneous closure may take place. Obstruction due to phimosis or a calculus may make a urachus reopen. A cyst may form in the urachus just below the umbilicus. A patent urachus is cured by dissecting it out down to the bladder, inverting its lower end and suturing.

Fæcal Fistula.—If there is still a patent Meckel's diverticulum existing at birth, fæces may escape. After it has been proved that the intestines and rectum below are patent, the fistula is dissected up to the ileum, invaginated and sutured.

A fæcal fistula may also be due to the bursting of a fæcal abscess following tubercular disease, intestinal obstruction etc.

Sinuses.—A sinus discharging pus may be biliary, perityphlitic, parametric, in origin, or an empyema may travel down between the ribs and diaphragm into the abdominal wall, and so burst at the umbilicus.

Tumours of the Umbilicus.—Papillomas are often irritative in origin; pedunculated tumours are excised, and the stump cauterized. Sessile tumours are excised with the umbilicus. Epithelioma and sarcoma grow in the umbilicus, and when they arise subsequent to inflammation are difficult to diagnose. If not removed, the growth spreads rapidly in the abdominal wall, and involves the intestines beneath. Wide removal, including the peritoneum, is the only cure. In doing this a small exploratory incision is made on one side, and the finger inserted to see whether the growth is free beneath. In this way malignant disease extending secondarily from the peritoneum to the umbilicus is excluded.

Abdominal Injuries.

In the absence of any specially localizing symptoms, the nature of abdominal injuries not attended by an external wound remains obscure. Any considerable injury is attended by much shock, a weak pulse, cold extremities, and a pale face. Consciousness is partially or completely lost for the time. Bruising of the abdominal viscera is generally the only diagnosis which can be made.

The treatment is expectant: absolute rest, warmth, a fluid diet, small doses of alcohol as a stimulant, drawing off the urine, and the evacuation of the bowels.

Special Indications for Abdominal Incision.—Air in the peritoneal cavity is indicated by the loss of the liver dulness and by abdominal distension. This condition indicates a rupture or perforation of the stomach or intestines, and an operation for suture should immediately be done.

Hæmorrhage into the peritoneal cavity causes marked pallor, with a weak pulse, shallow respiration, and is attended by the collection of fluid in the peritoneal cavity, as shown by dulness to percussion about the liver or spleen or in the flanks.

The bleeding-point must immediately be sought for. It may be dealt with by simple ligature, by a pedicle ligature and excision, or by suture of torn and bleeding surfaces.

There may be special indications of a ruptured kidney or of ruptured bladder.

Perforating Abdominal Wounds.—Among the causes of perforating abdominal wounds are bullet wounds, stabs, goring by bulls, etc. The indications are entirely in favour of immediate exploration. The expectant treatment is very fatal in its results.

The escape from the wound of the contents of the stomach or of the intestines, of flatus, or of blood, may further indicate the nature of the accident.

An expectant treatment was formerly adopted for bullet wounds, but to wait until the onset of peritonitis is to delay until the most skilled surgical aid is in vain. As soon as the patient can be brought under proper surgical conditions, an exploration should be made. An extraordinary number of intestinal perforations have been successfully sewn up. The small punctures made by a revolver bullet are sought for by passing the bowel systematically through the fingers from above downwards. After this air is pumped into the intestines by a ball syringe inserted into the rectum. Any specially bruised piece of bowel, or where the mesentery has been torn away, must be excised. The operation should be completed by washing out the peritoneal cavity. Young adults show a strong tendency to recover after multiple bullet wounds, provided that peritonitis has not commenced, and that all causes of peritonitis are definitely removed by operation.

A further difficulty in diagnosis occurs when a puncture or bullet wound is on the margin of the abdominal cavity. Thus, a wound may seem to belong to the chest, yet extend downwards through the diaphragm into the abdominal cavity. A wound in the groin may pass obliquely upwards outside the peritoneum, yet finally perforate. An immediate exploration will do no harm, and may be the means of saving life. A wound in the neighbourhood of the liver is likely to injure large veins. A wound of the superior mesenteric artery or one of its branches entails gangrene of the corresponding bowel, as there is no sufficient anastomosis between the superior and inferior mesenteric, or between the branches of the superior mesenteric themselves.

An injury may cause a communication between the abdomen and thorax through the diaphragm, especially on the left side. The diaphragm may be ruptured by a crush, and, owing to the passage of intestines into the chest, there is a loss of the breath-sounds, the lower thorax yields a stomachic note on percussion, and these signs are accompanied by symptoms of acute or chronic intestinal obstruction. Such a case should be treated by an abdominal incision, the gut reduced, and the gap sewn up. Wounds of the diaphragm are frequently seen in Italy, due to the stab of a dagger aimed at the heart. The omentum commonly prolapses. The punctured wound is enlarged, the prolapsed omentum reduced, and the rent in the diaphragm sewn up.

Peritoneal Cavity.

Air escapes into the peritoneal cavity from intestinal perforation, and is especially indicated by increasing abdominal distension and loss of the usual liver dulness.

Intestinal Contents.—Before incision extravasation is diagnosed by sudden collapse, air in the peritoneum, and vomiting. On opening the abdomen the contents are smelt and seen, varying according to the level of perforation.

Free Fluid is indicated by distension and dulness to percussion. If small in quantity, the signs are limited to the flanks, and the distension and dulness disappear on the patient turning to the opposite side.

Serous fluid collects in ascites and in malignant disease.

Blood.—Hæmorrhage is indicated by the sudden collecting of fluid along with acute anæmia. Arterial blood is bright red, that from the liver and veins dark blue.

Pus.—Turbid fluid, more or less purulent, occurs chiefly in the ascitic form of tuberculous peritonitis.

Purulent peritonitis is nearly always an acute septic infection, either from the exterior, or through a perforation from the alimentary canal, or from weakening of the wall of that canal so that bacteria can pass through, although there may not be an actual perforation sufficient to permit of the escape of either gas or fluid fæces.

Urine escapes from an intraperitoneal rupture of the bladder, and if normal there is not much decomposition, and only subacute peritonitis for a day or two. If not quite healthy, there is acute septic peritonitis immediately.

Bile is extravasated on rupture of the gall-bladder. If previously aseptic, the peritonitis is simple and subacute; if septic, acute septic peritonitis follows at once upon the rupture.

Encysted Fluid.—The signs of fluid are confined to a definite region of the abdomen, *e.g.*, the right inguinal region. It is distinguished from cysts, enlarged gall-bladder, ovarian cysts, and distended urinary bladder, by position, and from rarer conditions, such as hydatid, or pancreatic, or mesenteric cysts, by the encysted fluid being at once less tense and less circumscribed.

CHAPTER XXIX.

INTESTINAL OBSTRUCTION AND HERNIA.

Intestinal Obstruction.

INTESTINAL obstruction is indicated by the distension—chiefly with gas—of the intestines above the obstruction, the arrest of the peristaltic action and its reversal, constipation, and vomiting. The site of the obstruction and its cause may be evident by the presence of a hernial protrusion, or may be more or less obscured by the abdominal wall and by the intestinal distension. The patient's general condition is influenced by the failure to absorb food, by the exertion of vomiting, by the absorption of the decomposing intestinal contents, by the flow of fluid from all parts of the body into the intestines, so that the circulation weakens rapidly, as is seen by the fall in pulse tension and the shrinkage of the tissues. The respiratory and other bulbar centres fail, and death ensues. Meanwhile local changes go on in the gut at the site of the obstruction, at first venous congestion, then inflammation admitting of the escape of bacteria and the commencement of peritonitis, then gangrene, and finally ulceration and perforation. The peritonitis may remain localized—*e.g.*, in a hernial sac—or may spread throughout the cavity. The omentum may be involved with the intestines or alone. When the omentum alone is involved, the conditions are similar, although less severe. The omentum suffers when constricted from venous obstruction, inflammation, and even gangrene, from which a peritonitis starts, the only difference being that there is an absence of perforation unless the gut be secondarily involved by the inflammation, or by being dragged on and kinked.

When only a part of the lumen of the bowel is constricted, ulceration and perforation may occur whilst motions are still passed, and this happens in partial enterocele or Richter's hernia.

Relief follows the removal of the cause of the obstruction, the recovery of the peristaltic action of the intestines, and the arrest of the peritonitis. Granted the removal of the cause of the obstruction by the surgeon, yet, if too severely congested or inflamed, recovery of peristalsis does not occur, the segment of bowel remains paralyzed, the venous congestion and inflammation continue, and ulceration and perforation follow. This can only be avoided by an early removal of the obstruction, or by excision of the injured portion of the bowel. Peritonitis following perforation is of such a septic character that anything beyond a local infection renders the case practically hopeless. The local peritonitis may be stopped by drainage; for general peritonitis the peritoneal cavity is washed out thoroughly, but success can scarcely be expected.

Hernia.

The essential thing in any external hernia which does not follow upon an open wound is the protrusion of the elastic peritoneum, which pushes in front of it, and stretches the structures of the abdominal wall, especially the fibrous layers and the skin, whilst it displaces and passes between muscular fibres. The sites for external hernia are at weak spots in the wall. The pouch of peritoneum is protruded by the pressure of the abdominal contents, and is followed by them according to their mobility, intestines and the omentum being therefore the usual ones met with. Accordingly, the general symptoms of hernia are those yielded by the intestines when partly or wholly obstructed. When there is only partial obstruction, there is uneasiness, griping pains, constipation or diarrhœa, nausea or actual sickness after taking food; the more marked signs of complete obstruction are severe pain referred especially to the umbilicus or to the tumour, and vomiting with increasing abdominal distension.

The signs of an external hernia are the formation of a tumour, which is increased on cough or strain. On applying the hand, there is found an impulse on coughing, which is the more marked the wider the communication with the abdomen, and is less when the ring is narrow, and may be altogether obscured if there is a very tight constriction, and if the contents of the sac are tense.

On percussion, a tympanitic note is yielded when the contents are gut. The note is obscured by the addition of fluid in the sac, or the tumour is altogether dull to percussion when the only contents are omentum or fluid. A hernia containing intestine is uniformly elastic; that containing omentum is doughy to the touch, or is softly nodular. When the hernia is reducible, it becomes less tense on pressure, and finally returns through the ring with a perceptible gurgle, after which the skin can be invaginated, so that the finger can enter the ring.

Inguinal Hernia.

The site of inguinal hernia is determined by the gap in the wall, through which the testis has descended, and which is kept open by the spermatic cord, and the round ligament in the female. But in the latter case inguinal hernia is less common owing to the smaller gap.

A hernia at first enlarges the inguinal canal, and in those cases in which the external ring is closed, and the testis undescended, the hernia cannot get further out, but extends upwards between the layers of the abdominal wall, hence the name interstitial hernia. When the hernia protrudes but a little from the external abdominal ring, it is called a bubonocele. By gradually increasing, it becomes a scrotal hernia. A hernia in the groin is distinguished from an enlargement of the inguinal glands by the general signs above noted. Moreover, the inguinal glands are superficial between the layers of fascia, are not fixed in the external ring, and afford no abdominal impulse. If the glands are simply enlarged, the swelling is lobulated; if the glands are suppurating, there is much inflammation of the skin. Occasionally a tense hydrocele of a hernial sac, of which the neck is closed, may be mistaken for a singly enlarged gland. It is very rare to have only one gland enlarged without some increase of the rest, but in either case the diagnosis is completed by incising the swelling. An inflamed hernia may be mistaken for a suppurating bubo when there is only a tag of omentum in the sac.

A scrotal hernia is distinguished from a hydrocele by the neck of the tumour and the external ring being occupied by a swelling which yields an impulse. A hydrocele is translucent, except when the wall is very thick or when blood has been extravasated. The intestine of a child is partly translucent. A very large hydrocele may extend up to the abdominal ring, but has no impulse. A hernia and a hydrocele often coexist. The latter should not be tapped unless the hernia can be first of all reduced; incision is safer.

Reducible Inguinal Hernia.

A hernia may return into the abdomen when the patient lies down, or do so on gentle compression. A gurgle should be perceptible, otherwise there is no certainty that the hernia has quite returned through the internal ring. With the forefinger, the upper and back part of the scrotum is invaginated, and the finger pushed gently into the external ring. If the gut is felt with each cough to protrude sharply against the finger, and then to return with a gurgle to the abdomen, it is clear that reduction is complete. When the finger in the external ring perceives a tense swelling, which causes some bulging of the spermatic canal, it must be concluded that reduction is incomplete owing to a constriction at the internal ring. In a hernia of old standing, the finger which invaginates the scrotum, and so engages in the external ring, perceives that the weight of the tumour has pulled down the inner ring until it is opposite to the external ring. So that if the rings are large enough, the finger can enter the abdominal cavity, and feel, for instance, the pulsations of the iliac artery. The deep epigastric artery lies behind and to the inner side of the ring. When, however, in comparatively rare cases the hernia is primarily a direct one, the deep epigastric artery lies in front and to the outer side of the inner ring, where its pulsations may be felt.

Taxis.

Taxis is the name given to the method of reducing a hernia by straightening the neck of the sac with the left hand, whilst gentle and equable pressure is made with the right, or *vice versâ*. To aid this, the legs are flexed at the hip, the pelvis raised, and the head and trunk lowered. No force should be used except that made by pressure of the palm ; there should be no pommelling, no digging in of the fingers. Only in large hernias of long standing may both hands be employed to grasp the swelling.

Taxis is employed in a gentle way when the symptoms of strangulation have not begun, or have not lasted longer than a day. Beyond these limits the practice of taxis is far more dangerous than an open incision.

The complications produced by forcible taxis are bruising of the bowel, so that perforation is hurried on, or the bowel is actually ruptured, and its contents extravasated into the sac, and pushed back into the peritoneal cavity. The bowel may be simply returned into the spermatic canal, but not through the internal ring. No gurgle attends the process. There is an elastic swelling in the spermatic canal, which can be touched by the finger passed into the external ring. A rent may be made in the sac, through which the contents of the sac are pushed into the tissues in front of the peritoneum, but still constricted by the internal ring. Or at the neck around the gut an inflammatory band is formed, and the knuckle of gut is reduced into the peritoneal cavity, but still tightly constricted. The general symptoms of intestinal obstruction continue, and there is an ill-defined resistance or swelling in the inguinal region.

Such complications ought never to occur. The operation for a hernia is now a thoroughly successful one whenever undertaken early. It is the delay before operating which is the origin of all the danger.

The Treatment of a Reducible Hernia by a Truss.

If there is merely a weakness of the abdominal wall, so that bulging occurs with cough, or the patient feels a sensation of yielding whilst taking active exertion, such as riding, or if the hernia does not protrude far, and is easily and completely reducible, then the application of a truss may not only arrest a further increase, but if it fits well and keeps the hernia up under all circumstances, the hernia may after a year or so altogether cease to come down.

A truss should consist of a soft pad placed over the internal abdominal ring, not over the external ring, as is too often the case. The spring must fit the patient, and only press with just sufficient tightness to keep in place; in addition, a perineal band is required to prevent riding up. Any condition favouring hernia must be removed, such as phimosis, stricture, constipation, and the patient must be warned against growing fat. The truss should have a washable covering, and should be put on in bed before rising. A truss is unsuitable for an active, hard-working patient, in whom the hernia is apt to come down beside the pad. Trusses get weak, and fail to keep up the rupture. The operation for the cure of hernia offers great advantages over trusses for all young men and those engaged in hard labour, who cannot afford to renew them as soon as they get weak. It is evident that, since operations for the cure of hernia have come into practice, the number of strangulation cases, and therefore the mortality from hernia, has been much diminished.

A truss should not be applied to an irreducible hernia. All modifications in the shape of hollow pads are unsatisfactory, and apt to set up inflammation. The only exceptions are the cases of very large hernias of old men, in which the abdomen has so shrunk that the intestine could not be returned in any case. In them a strong scrotal suspender, with braces over the shoulders, gives the necessary support and enables them to move about.

Irreducible Non-Strangulated Hernia.

A patient who is suffering from a recently irreducible hernia, but in whom no symptoms of strangulation have appeared, is put to bed, an ice-bag or ice-poultice is applied over the swelling, and a large soap-and-water or castor-oil enema is given to move on the flatus. A purge may be given after a day or two's rest. If the contents consist mainly of omentum, especially in the case of a fat woman with umbilical hernia, a reduction of the obesity may be useful.

Irreducible Hernia threatening Strangulation.

Among the slighter signs pointing to strangulation are local pain, abdominal distension, a furred, dryish tongue, nausea or vomiting of the contents of the stomach on taking food. Constipation is usually present, but fæces may pass owing to the bowel emptying below the stricture. When there is constriction of the omentum, or of part of the lumen of the gut, motions may continue, and there may be even diarrhœa. One attack of fæcal vomiting is sufficient to show that an irreducible hernia is becoming strangulated.

Strangulated Hernia.

There is only one course of treatment for strangulated hernia, viz., herniotomy, or the reduction of the hernia after dividing the constriction through an open incision under an anæsthetic.

In the meantime, whilst preparations are being made for the operation, the patient should be wrapped up warmly in bed, with hot-water bottles, until he perspires, and he should take as much hot water as he can. In this way the patient washes out his own stomach by returning the hot water swallowed, so that there is less danger of fæcal vomiting whilst under the anæsthetic. In addition, some of the water is absorbed, and replaces that lost by the vomiting, and so diminishes the tendency to collapse by improving the circulation.

A hot bath should not be given. It causes pain and exhausts the patient, without doing any good; for, as a matter of fact, the constriction is not muscular, but fibrous, not superficial, but deep-seated at the internal ring; even if the muscular tension were the main obstacle to reduction, it is much better relaxed by an anæsthetic.

Opium is an entirely harmful drug for use in a case of suspected strangulation. It should never be given, for it simply masks the symptoms, and causes the operation to be put off until it is too late. The more painful the hernia, the more urgent the herniotomy.

Operation for the Cure of Hernia, whether Strangulated or not.

The patient is prepared by shaving off the hair from the pubes and scrotum, and applying a carbolic dressing after cleaning. Before commencing the incision, the penis is wrapped up in a piece of lint, wrung out of 5 per cent. carbolic acid lotion. The incision is made parallel to and immediately above Poupart's ligament, having its centre over the internal abdominal ring. The incision should be made at this spot, irrespective of the size of the hernia, and not over the external abdominal ring or upper part of the scrotum. The incision is made by pinching up and transfixing the skin. The wound is retracted, and the various layers are divided by raising them between two pairs of anatomy forceps. No object is served by attempting to recognise the various layers; they should not be dissected up lest pockets be left. The veins and arteries running with them which cross the sac can generally be divided between two clamps. By raising the layers between anatomy forceps the incision can be made without hesitation until the sac is entered. The opening of the sac is indicated by the escape of fluid, the exposure of omentum or intestine, and this fact can be confirmed by inserting the finger and feeling the constricting internal ring, or, through the ring, the abdominal cavity.

The subperitoneal fat may be hypertrophied, but it cannot be mistaken, for it has no pedicle connecting it with the abdominal cavity. The wall of the sac cannot be mistaken for intestine, because it is continuous with the abdominal wall. The bloodvessels of the sac are small, and distributed in a network over the sac. The vessels of the omentum radiate from the pedicle; the intestinal bloodvessels run in a circular fashion.

The Sac.—The sac is commonly a distinct pouch of peritoneum, the spermatic vessels and the vas deferens lying behind it, and the testis below. The sac, however, may adhere to the testis, or a communication may form with the cavity of the tunica vaginalis testis. Less commonly the protrusion of peritoneum carried down by the descent of the testis remains unobliterated, and forms the hernial sac, so that the testicle bulges into the sac, or hangs freely by a mesorchium. This so-called congenital hernia is much less common even in young children than the ordinary type. But although the funicular process remains unobliterated, no hernia need form, or the hernia may appear late in life, the immediate cause being presumably an elongation of the mesentery. The sac may be a single uniform cavity, or it may be partly loculated, dilated in the spermatic canal, constricted at the external abdominal ring, dilated below, and constricted again at its communication with the tunica vaginalis testis. Exceptionally the sac is imperfect, or, indeed, is absent, owing to the slipping of the gut down behind the peritoneum.

The lining of the sac is generally smooth. It may, however, be thick and roughened by inflammation, with bands passing across, or adhesions uniting it with its contents.

The Contents of the Sac—*Fluid.*—There is usually, although not always, some fluid in the sac. The fluid is clear, straw-coloured serum, when there is no strangulation. It becomes more and more darkly stained as strangulation goes on. Before gangrene actually commences, the fluid takes on a greenish hue, and begins to smell, owing to the passage of organisms through the inflamed bowel. When the fluid has a definitely fæcal odour, gangrene of the intestines is present, or perforation has actually taken place.

Omentum, Epiplocele.—The omentum in the sac may be perfectly normal, or thickened by inflammation, or matted together into a mass round a small knuckle of intestine; or the omentum may have already become gangrenous. It may be adherent to the sac at the neck. It may form a loop, with the free end in the abdomen gangrenous.

Intestine, Enterocele.—Any part of the small or large intestine may be found in the sac, either by itself, or co-existing with omentum. The gut may be unaltered, or may be slightly congested, with a pale band where constricted; or the knuckle may be of a dark plum colour, roughened with lymph on its surface, but the surface still shining and bleeding when scratched. Gangrene has commenced, and the coil of intestine is past recovery, when there is a distinct fæcal odour; then the surface of the affected gut is a dead black, and does not bleed when scratched; flakes of pus are present on it, or a deep ulcer is found at the line of constriction. The gut may have already perforated, and fæces be found extravasated.

When the constriction includes only part of the lumen or a diverticulum, it forms a partial enterocele or Richter's hernia, and there may be no intestinal obstruction accompanying the strangulation—indeed, even diarrhœa.

Amongst the unusual contents is a pouch of the bladder. A sign by which this may possibly be recognised beforehand is the desire to pass water when taxis is made. The pouch is known by the muscular fibres which cover it. However, the pouch may be composed only of mucous membrane, and may be cut or torn unawares, when urine will escape. A stone has been found in the pouch.

In the female the ovary, or tube, or cornu of a bicornuate uterus, may be found in the sac; the latter may at first sight be confused with the appendix vermiformis.

Division of the Constricting Ring.—This constriction is usually a thickening of the peritoneum at the internal ring; less often the constriction is due to the external oblique at the external ring. The latter is divided in the course of exposing the sac. The constriction at the internal ring should be also divided from without inwards after retracting the wound, depressing the intestine, and slitting up the sac. In dividing the ring from without inwards the eye can guide every step of the knife, and there is no difficulty with the tightest ring. The classical method is to pass a curved, blunt-topped bistoury through the ring, either on a director or guided by the finger, and then to notch the ring upwards and outwards. But this is a procedure done out of sight: a coil of intestine has often been nicked, for a forcible expiration may drive the gut against the edge of the knife, or a fold of the gut can easily get into the way when the ring is tight. It was an expeditious plan, suitable for operations without anæsthesia. It has now no advantages, and runs counter to the surgical rule that everything should be done under the guidance of the eye. In the case of direct hernia there is, by the above method, less danger of wounding the deep epigastric artery, as it runs in front and to the outer side of the neck of the sac.

The Return of the Contents of the Sac.—The omentum, if small in amount and unaltered, is washed and returned. If large and matted together, it is firmly tied by a pedicle ligature and the mass cut away. It is most important that every vessel should be included in the ligature, especially tags at the side must not be overlooked. A good frill should be left beyond the ligature so that it cannot slip. If the first ligature applied does not stop the bleeding, another must be put on above it. In applying the ligature care must be taken not to include a loop of intestine in the middle. Before closing the wound, the stump of the omentum should be finally inspected, and then the ligatures are cut short. If the omentum appears gangrenous right up to the ring, it must be followed up even into the abdominal cavity, until the stump on the proximal side of the ligature is healthy. If it forms a loop the whole must be pulled down.

The bowel is inspected, especially at its line of constriction, washed, and returned. Occasionally this is rendered difficult by the coil being distended by fæces, flatus, blood or fluid secreted. Then the surgeon must choose between dividing the ring widely, or aspirating the bowel and suturing the puncture, or making a short incision, evacuating the contents, and closing the incision by a suture.

Gangrene of the Intestine.—When the bowel has an ulcer at the line of constriction, or is probably, although not certainly, affected with gangrene, the ring is divided and the bowel left in place, or it may be fixed by one or two superficial sutures. Should it give way, fæces will escape outwards; should it recover, the bowel can be returned and the ring closed at a subsequent operation. If the fæces do escape, it will be only by a small opening, which spontaneously closes, or at least the fistula can be cured more easily than an artificial anus with a well-formed spur.

If gangrene has set in, and perforation has taken place, the choice of procedure lies between excision of the gangrenous gut and the formation of an artificial anus. The two measures are equal as to danger. Excision is dangerous owing to the extra shock by prolonging the operation, and to the widespread paralysis of the intestines, so that apparently healthy sutured ends are liable to become gangrenous later on, setting up septic peritonitis. The formation of an artificial anus is rarely successful, except when the large intestine only is involved. If an artificial anus be made in the small intestines, liquid fæces and undigested food pour out, and the patient rapidly wastes. In addition, gangrene may spread to the bowel on either side of the artificial anus. If the patient recovers, another operation is required to close it. Therefore, except in the case of the colon, and in very exhausted patients, immediate excision and suture is to be preferred, for if it is successful the patient is cured.

The appendix vermiformis is returned, unless it appears diseased, or has already ulcerated. It is then removed in the way prescribed.

A pouch of the bladder is carefully returned. If it has been opened, the edges should be invaginated and sutured; but it will be safer not to close the wound, but to fill it with gauze. If leakage then occurs, there is no danger of extravasation of urine, and the urinary fistula will soon close.

If the ovary and tube are found in a hernia, they are returned, unless diseased, when they are ligatured and cut away.

A retained testis is generally an abnormal one, and when there is a full-sized organ on the opposite side, it is scarcely worth while to attempt to save it, and it should be removed. When, however, there is no testis, or only an abnormal one on the opposite side, the retained testis should be placed in the scrotum and fixed down by a suture through the skin of the thigh.

The Treatment of the Sac.—When the sac is healthy, it is returned so as to form a plug within the abdominal ring.

doing away with the funnel-shaped depression which predisposes to the formation of a hernia. To do so the sac is separated by the fingers, by anatomy forceps, or by the knife, up to and just beyond the internal ring. A ligature is then run lengthwise through the sac wall, one end is tied at the bottom of the sac, the other is threaded on a long-handled needle, and, guided by the finger, is carried through the internal ring and passed out through the abdominal wall at the outer angle of the wound. The sac is washed, and after the finger has felt that the ring is quite free, the outer end of the ligature is drawn on, and so the whole sac is invaginated, and lies puckered up within the ring (Fig. 76, 1 and 2). When the sac is intimately adherent to the testis, or communicates with the tunica vaginalis, or is of the congenital type, the whole sac cannot be removed, but part

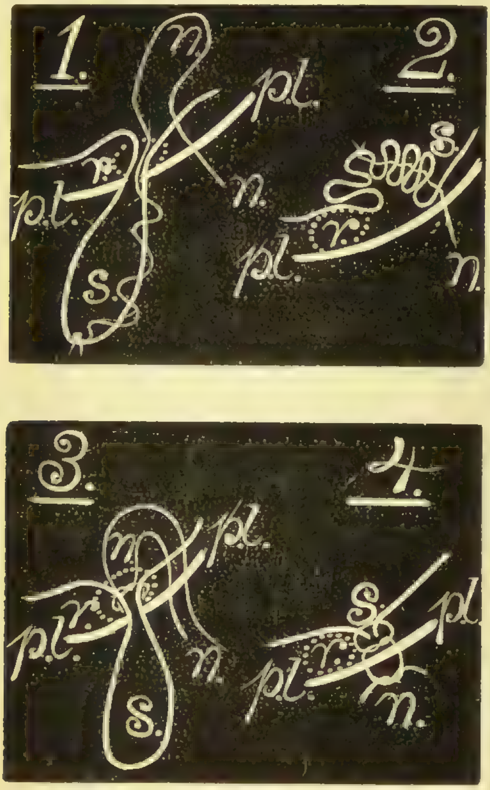


Fig. 76.—Treatment of the Sac. 1 and 2, Invagination of the Sac; 3 and 4, Ligature of the Neck and Excision of the rest of the Sac.
p l, Poupart's ligament; *r*, internal ring; *s*, sac; *n*, ligature.

must be left. If the sac is diseased, instead of returning it, the neck may be ligatured, and the rest cut away (Fig. 76, 3 and 4). Then the ends of the ligature round the neck are threaded through the wall and tied, so as to fix the stump of the sac to the inner surface of the abdominal wall. This closure of the sac is always done, except when the perforation of the gut is feared: then the wound must be left open, or a drainage-tube inserted up to the inner ring.

Suture of the Hernial Opening.—A suture is always applied, whether the hernia has been beforehand strangulated or not, except when perforation is to be expected. In order to do so, it is necessary, after completely returning the sac, to distinguish the aponeurosis of the external oblique from the internal oblique and transversalis muscles united in the conjoined tendon. The outer pillar formed by Poupart's ligament is also defined, and the spermatic cord, including the vas deferens between the inner and outer pillar. The object in applying the suture is to draw the yielding muscle of the inner pillar across to the rigid outer pillar, so as to restore the spermatic canal to its originally oblique condition. This is done by passing the ends of the suture through the muscle of the inner pillar, then through Poupart's ligament,

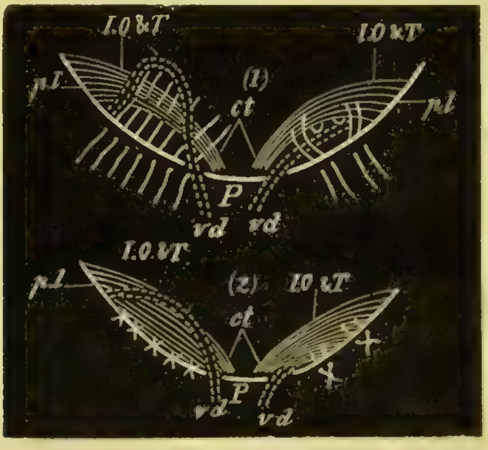


FIG. 77.—SUTURE OF THE HERNIAL OPENING. (1) SUTURES INSERTED; (2) SUTURES TIED.

Left side, Quilted sutures, the vas deferens lying in the canal (MacEwen's method). Right side, Interrupted sutures, the vas deferens retracted so as to lie in front. *I O & T*, Internal oblique and transversalis muscles; *p l*, Poupart's ligament; *c t*, conjoined tendon; *p*, pubes; *v d*, vas deferens.

in both cases from within outwards, and at about $\frac{1}{2}$ inch apart, and knotting the ends tightly (Fig. 77). The aponeurosis of the external oblique is not taken up with the muscle, for its elasticity causes it to retract and weaken the suture, especially when the patient vomits or coughs. The vas deferens is left in place, running through the restored spermatic canal. An alternative plan is to raise and draw it aside, whilst the muscle and conjoined tendon are united to Poupart's ligament, after which the vas comes straight through the abdominal wall at the level of the inner ring, and runs down superficially beneath the skin. The skin is nearly always completely united ; but when the scrotum has been much stretched, and a cavity is left by the removal of the sac, a drain should be inserted into the most dependent part through a small hole. This avoids the danger of œdema or of fluid collecting in the scrotum, which is not readily absorbed. The tube is removed at the first dressing, and, as it is short, in no way interferes with the healing of the wound.

In exceptional cases the wound is filled with gauze, and made to heal up from the bottom by granulation, so that a firm pad of scar-tissue is produced.

Dressing of a Hernial Wound.—For simple cases a collodion dressing suffices, the testicles being suspended by a pad of wool and a **T**-bandage. After reduction of a large scrotal hernia the patient is raised on a pelvic block, and a double spica bandage is applied: one turn goes round the leg, and the next turn across the perineum. A pad of wool is placed so as to keep up the scrotum. Over the bandage is pinned a sheet of jaconet, with the glazed surface outwards and perforated for the penis, or tucked in round the vulva in the female. The patient lies on his back in bed with the knees raised by a pillow, and the urine may have to be drawn off, especially in the female. The case is treated in the same way as other abdominal operations. Opium should not be given, injections of morphine are only required to relieve pain. The bowels should be opened by an aperient or enema on the second, or at any rate on the third, day, after which there should be a daily motion. The more extensive the damage done to the intestines or omentum, the more successful this treatment. The patient should be kept on his back for a month. No truss is required afterwards in most cases.

The only complication to be feared is the paralysis of the constricted loop of bowel, its congestion, and, later on, gangrene and perforation ; and the best protection against this danger is gentle peristalsis, and the prevention of stagnation and fermentation of the intestinal contents within the damaged gut. The symptoms of paralysis of the bowel are a dry, shrunken tongue, a rising pulse-rate, tympanites, nausea or vomiting. If these conditions persist after the bowels have moved, the question of excision of the injured gut may be raised, but success is unlikely.

Other Varieties of External Hernia.

Ventral Hernia.—A ventral hernia is a protrusion of all the layers of the abdominal wall, generally in the scar of a wound or abscess, or after a subcutaneous rupture of muscle. There is a wide communication with the abdomen, so that strangulation does not take place. Less commonly, the muscular structures are pushed aside by a protrusion of peritoneum, and then a ring may be formed. Ventral hernias are prevented by careful union of wounds, late removal of sutures, the application of an abdominal belt before getting up, a regular action of the bowels, the relief of a cough, and the prevention of obesity. If an operation is required, the abdominal wall is sutured in stages by bringing together the muscular and aponeurotic structures separately. The peritoneal cavity need not be opened. The hernias which occur after operations are commonest in the middle line, but also occur in the loin, after removal of the appendix, etc.

Obturator Hernia.—Obturator hernia occurs in women. The special local symptoms are pain extending down the inner side of the leg, and inability to extend fully the hip joint. Some fulness may be present in Scarpa's triangle. There are also the general intestinal symptoms, but not necessarily constipation, owing to the hernia being often a partial enterocele. When the latter are chiefly in evidence, the abdomen is opened, and then the gut is withdrawn with the greatest care, and the peritoneal ring is sutured. As the ring is sharp, if strangulation has lasted more than twenty-four hours, the bowel is very likely to give way as it is withdrawn. This danger must be anticipated by protecting the rest of the abdomen with sponges, and by gently clamping the gut on either side. Fulness in Scarpa's triangle—especially when the woman is fat, and the outlines of the saphenous opening cannot be made out—may attract attention, and an exploration may be made as if for a femoral hernia. The obturator hernia will be found deeper after dividing the fascia. But the external operation for obturator hernia is unsatisfactory because it does not allow of any inspection of the bowel.

Femoral Hernia.—Femoral hernia is the more common hernia in women, but is much less frequent in men than the inguinal form. It likewise is generally seen in old patients. The gut enters the crural canal, fills the saphenous opening, and then protrudes upwards and outwards, superficial to Poupart's ligament. It is distinguished from inguinal hernia by being below Poupart's ligament, as seen by the fact that the spine of the pubes lies above and internally.

Femoral hernia is distinguished from an enlarged gland by the impulse, by the tumour being connected with the saphenous opening, and by the fact that there is usually more than one gland enlarged. It is differentiated from a varicose dilatation of the saphena vein by the impulse in the latter case being of fluid, as in other enlarged veins, such as varicocele, and by the presence of dilated veins in the leg below. The falciform and Gimbernat's ligaments form the constricting bands, having sharp edges, and thus strangulation is attended by more rapid gangrene of the bowel than in the inguinal form.

A hot bath is absolutely useless, and so is the administration of opium. Taxis should never be attempted more than twenty-four hours after strangulation. Anæsthesia does not improve the chances of taxis. The incision is made vertically over the saphenous opening. It is generally impossible to recognise the layers; the subperitoneal fat is often much thickened and matted together. The sac may contain fluid or not, or fluid may accumulate superficial to the layer actually covering the intestines. Generally, a mere knuckle of gut is found. The ring is often very tense, and the best way is to cut through the inner end of the falciform ligament from above downwards, guided by the eye. If a hernia knife is used, Gimbernat's ligament is notched on the inner side, so as to avoid the vein and the obturator artery. The obturator artery has been cut when passing to the inner side of the canal, and then requires a ligature.

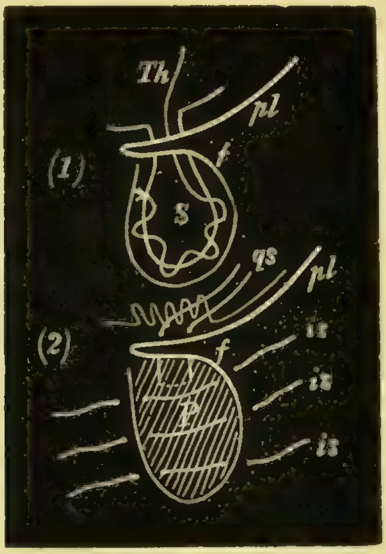


Fig. 78.—Closure of Femoral Hernia Opening. (1) Invagination of the Sac; (2) Insertion of Sutures.

Th, Ligature; *s*, sac; *pl*, Poupart's ligament; *P*, pectineus muscle; *qs*, quilted suture drawing pectineus towards Poupart's ligament; *is*, interrupted suture for closing saphenous opening.

In any case of difficulty the wound is enlarged upwards by dividing Poupart's ligament close to the spine of the pubes. The treatment of the sac is the most important point as regards cure. The whole sac or its ligatured neck is fixed by sutures to the wall in front, so as to plug the entrance to the canal. Sutures are often merely adjuvants. They can be passed through the superficial part of the pectineus muscle, so as to fill the canal, and the fibrous margins of the saphenous opening are drawn together (Fig. 78).

Threatened or actual gangrene of the gut is treated as in inguinal hernia.

Umbilical Hernia.—There are two forms, one in infants and the other in women. Infants suffer from umbilical hernia owing to the imperfect closure of the umbilical ring. A hernia into the cord may be found at birth, or appear before the skin has healed, and may even become strangulated. A protrusion may be noticed after the healing of the cord. It is easily reducible, and can be kept in place by a soft pad beneath the usual belly-band. An umbilical truss is but rarely required. Spontaneous closure occurs before two years, more speedily if there is no diarrhœa, bronchitis, or phimosis to keep it up. Umbilical hernia is therefore not seen in older children and young adults.

Women in whom the abdominal wall has been weakened by child-bearing, and who are tending to form fat in the omentum and mesentery, develop umbilical hernia by a protrusion of peritoneum between the fibres of the linea alba. The sac, therefore, becomes subcutaneous, and later on adheres to the skin. A piece of omentum soon becomes fixed in this sac, so that the hernia is never afterwards really reduced. At any time a loop of intestine may slip into the sac, and become strangulated by the sharp edge of the ring in the linea alba. The adherent omentum increases in size, the sac becomes loculated, the ring larger, and intestines—either the transverse colon or small intestine—fill the sac; but a portion of the contents, although not the whole, generally returns whilst lying down. Strangulation is caused by an extra loop of bowel slipping through the ring. The patient has usually become accustomed to slight troubles, such as constipation, nausea, or vomiting after food, distension, pain, so that the increased severity of the symptoms occurring with strangulation is at first treated lightly. If the strangulation lasts longer than twenty-four hours, collapse sets in, inflammation and gangrene of the gut follow, or, in a fat old woman, rapid collapse and almost sudden death may ensue before the local changes have time to advance very far.

Rest in bed, free purgation, and the reduction of obesity, may be the means of diminishing the size of a large umbilical hernia, and of preparing the patient for operation. Trusses and belts are used when the hernia is apparently reducible, but, as is nearly always the case, the adherent omentum in the sac keeps open the ring, and at any moment a loop of intestine may slip into the sac and become strangulated.

Cure of Umbilical Hernia.—Excision of the sac and suture of the ring offers the only satisfactory treatment, for strangulation may occur at any time. Its early symptoms are often neglected, and in late strangulation very little hope of success can be entertained. A semilunar incision is made through the skin on one side of the tumour, then on the other, sufficient skin being retained to meet in the middle line (Fig. 79). The hard, cartilage-like ring formed by the linea alba is next defined. By another semilunar incision on either side, this hard ring is excised along with the sac, intestine is returned, and the omentum ligatured and cut away. Care has to be taken in separating these structures from their adhesions to the sac, especially when the latter is loculated. The abdominal wall is sewn up in stages, first the peritoneum, then the two recti muscles are drawn together, then the sheath of the recti and the skin. The patient is fitted with a belt before she gets up; she should take aperients to prevent collections of flatus, and be told how to prevent herself from getting fatter.

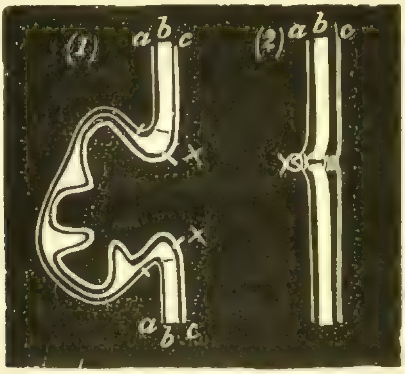


Fig. 79.—Closure of Umbilical Hernia Opening. (1) The Sac; (2) the Opening Sutured by uniting the layers separately.

a, Skin; *b*, muscle and aponeurosis; *c*, peritoneum. ×, the short bars mark the points where the skin, the aponeurotic ring, and the sac are cut through.

Sciatic or Ischiadic Hernia.—A knuckle of intestine has slipped into the great sciatic notch, and given rise to symptoms of intestinal obstruction, as well as of pain down the sciatic nerve. The strangulation is relieved by abdominal section.

Perineal and Vaginal Hernias occur in women. See Prolapse of the Uterus.

Intestinal Obstruction not due to an External Hernia.

The sign of intestinal obstruction is the distension of the bowels. There is also constipation, except for the emptying of the gut below the obstruction, and also when only part of the lumen of the gut is involved. Intestinal obstruction in childhood is commonly due to intussusception. About puberty trouble in connection with the appendix or Meckel's diverticulum, or bands produced by peritonitis, may be looked for. In middle life, besides the foregoing causes, there occur internal hernia through apertures in the omentum, or mesentery, through the foramen of Winslow, into peritoneal pouches at the junction of the duodenum and jejunum, or in the region of the cæcum, volvulus, and obstruction of the intestinal contents by gall-stones, by enteroliths, etc. The older the patient, the more likely is the cause of obstruction to be a tumour, generally a malignant one.

The indications for operating in a case of intestinal obstruction are the failure of purges and enemas, fæcal vomiting, increasing rapidity of the pulse.

The treatment before the operation consists in the patient taking as much hot water as he can, and in the administration of nutrient enemata, with or without brandy. Before commencing the operation the mode of procedure should be decided on, the choice lying between three methods: drainage of the intestine, opening the abdomen widely and letting out the intestines, making a small opening and exploring whilst keeping in the bowels.

Drainage of the bowel is suitable for exhausted and aged patients in whom, from whatever cause, the circulation has already become weak. Temporary relief may be given without the necessity of completing the diagnosis, and further measures may be taken after the patient has regained strength. An incision about 2 inches in length is made in the middle line, and the most distended loop of intestine drawn forwards. In order to do this it may be necessary to exhaust some of the gas with an aspirating syringe. A large glass cannula is inserted into the loop and tied, and the cannula is connected with a collecting vessel by a rubber tube; or a rubber tube without side-holes, large enough to tightly fill the hole made in the gut, may be fixed in by sutures. In this way all fæcal contamination is avoided; the tube can be kept clear by syringing in water, and before the tube becomes loose adhesions will have formed sufficient to shut off the abdominal cavity. Drainage is continued until a diagnosis can be made. When the obstruction has been merely valvular, a kink owing to chance distension, then the drainage may be sufficient to cure. A free incision allowing the intestines to come out of the abdominal cavity is made, when the distended intestines cannot be pushed aside and retracted, so that a diagnosis cannot be made except with great difficulty and delay to the surgeon. Coils of intestines are let out on to the abdomen, which has been beforehand well cleaned, and are there covered by protective or oiled silk and antiseptic gauze wrung out of hot water; pads or towels which have been sterilized may be employed, or towels or lint may be steeped in hot 5 per cent. carbolic acid and wrung out, provided that protective intervenes and prevents direct contact of the antiseptic with the intestines. The surgeon can then quickly complete the operation. If the cause of the obstruction is removed, the contents from the distended bowel above can be squeezed into the empty lower part, and so the whole can be returned to the abdomen. But if the gut is too distended to return, it must be aspirated, and the puncture closed by a suture. The objection to the escape of intestines is that there is more shock, and it is therefore most suitable for young and strong patients. It is unsuitable wherever there is already local suppuration, for the rest of the cavity becomes infected.

The third method is slower, but is more suitable where the diagnosis is uncertain, or where there is probably some local suppuration.

The surgeon makes a short incision, inserts his finger, and explores first towards the right iliac fossa, then towards the left, afterwards above the umbilicus towards the liver and spleen. The bowel is kept in the peritoneal cavity; if distended coils are in the way, each loop is aspirated by using a fine needle, and closing the puncture with a stitch. In this way the field of operation is gradually exposed, and is shut off from the rest of the abdomen by packing in sponges. Meanwhile the surgeon may find it expedient to make another incision, inguinal or lumbar, for the removal of the obstruction, then the short incision in the middle line can be closed.

The one essential point is to relieve the distension on the table, whether by aspiration, by incising and letting out the contents and closing by suture, by drainage, or by removing the obstruction and actually seeing that the contents of the distended bowel move on at once. A constricting band is divided between two ligatures, the loop of bowel in an internal hernia is withdrawn, and the opening closed against recurrence by suture; an appendix or Meckel's pouch is excised; an intussusception is withdrawn, or, if this is impossible, the entering bowel is excised by Maunsell's method; a volvulus is untwisted, or the involved portion excised.

When a malignant growth is found which has not extended beyond the bowel, it should be excised and the ends sutured together. Before doing so the upper bowel must be emptied of as much as possible of its contents. When the growth is low down in the colon, and the patient old, with much distension, an artificial anus may be preferred, after excising the growth, to immediate suture, and the artificial anus can be cured later. But an artificial anus in the small intestine is more hopeless than immediate suture.

When the malignant disease is too extensive for removal, an anastomosis is made between the bowel above and the bowel below. After doing this the contents of the upper bowel should immediately flow into the lower; if there is no sign of this, the upper bowel should be emptied, otherwise it may remain paralyzed. When an irremovable growth is found low down, an artificial anus is made above, taking care that a spur is made.

Gangrene and perforation are treated, if possible, by excision; failing this, the perforation may be stitched to the skin incision, or a drain passed down to it, so as to lead off the fæcal material which escapes.

Foreign bodies in the intestinal lumen, if scybala, or soft gall-stones, or masses of worms, are squeezed onwards between the thumb and finger. If too hard, they are removed through a longitudinal incision, and, after emptying the upper bowel, the incision is closed.

See Chapter VIII., p. 91: The Surgery of Mucous Tubes and Cavities.

For colotomy and artificial anus, see p. 368.

CHAPTER XXX.

SURGERY OF THE STOMACH AND INTESTINES.

Washing out the Stomach.

This is not to be done without some clear indication, for in an exhausted patient considerable shock may be set up.

It is required to remove poison from the stomach, as a preliminary to an operation which will open the cavity of the stomach, and may be used for removing the remains of a meal some two hours or so after it has been digesting and before decomposition has set in. By this means dyspepsia may be relieved.

It is especially in cases of fæcal vomiting that the washing out of the stomach is likely to cause shock. It is best, therefore, to give the patient as much hot water as he can swallow. The first water drunk is vomited, and with it the fæcal contents, after which the vomiting diminishes in severity, and an anæsthetic can be given with greater safety.

Wound of the Stomach.

When a stomach is wounded by a stab or bullet whilst it is full, the edges of the wound in the stomach may prolapse into the parietal wound, become fixed there, and form a gastric fistula, without the extravasation of the contents into the abdominal cavity. When, on the other hand, the organ is empty, the wound is under the left rib cartilages, and only gastric juice escapes, unless the patient is given anything after receiving the wound. Apart from such cases, a wound or rupture of the stomach is followed by an extravasation of the contents into the peritoneal cavity.

The signs of a perforating injury of the stomach are: the escape of gas into the peritoneal cavity, so that the liver dulness is lost; fresh blood is vomited; gas having the odour of vomit, undigested food, and fluid giving hydrochloric acid reactions are recognised on opening the abdominal cavity. The gastric contents may escape through the external wound. Hæmorrhage is profuse when a large vessel of the stomach is injured.

An immediate exposure and suture of the wound is always required, the only exception being when the case is seen late after a gastric fistula has become established. A plastic operation can then be put off to a convenient occasion.

Ulceration and Perforation of the Stomach.

Ulceration generally occurs in anæmic young women, and much less often in men. Surgical interference may be called for under three circumstances: hæmorrhage, perforation, and the formation of a subphrenic abscess.

Hæmorrhage.—If hæmorrhage continues profusely from a gastric ulcer, and palliative measures fail, the stomach should be exposed, opened, and the bleeding-point sought for and tied or cauterized, or the ulcer excised and the edges drawn together.

Perforation. — The signs of perforation are sudden collapse, with the escape of gas into the peritoneal cavity. An operation should be carried out at once. A favourable termination is hazarded by waiting for signs of peritonitis, and the hope of a localization of the suppuration is chimerical when the symptoms of perforation come on acutely.

The patient is given a nutrient enema with brandy; an incision is made in the middle line from the xiphoid process to the umbilicus; the extravasated contents are washed out, and the rest of the peritoneum protected; the edges of the perforation are tucked in, and the peritoneal surfaces of the fold sutured. This is quicker than excising the ulcer before suturing, but the latter may have to be done, when the walls of the ulcer are rigid. A strip of gauze or drain may be inserted, or, where the contents have already spread over the cavity, a glass drain is put into Douglas's pouch through a separate opening, and the whole peritoneal cavity washed out; then the wound in the epigastrium is completely united.

Subphrenic Abscess. — A subphrenic abscess may be formed by the leakage from the stomach owing to an ulcer having slowly extended through all the coats to the peritoneum. The abscess may first form in the regions of the lesser omental cavity. It may come forwards and point in the epigastrium, or extend backwards and be felt behind above the head of the kidney. It may perforate into the thorax, and cause a left empyema, and communicate or not with a bronchus.

The signs are those of fever, and the formation of a fluctuating tumour, containing stinking pus and gas. It may discharge through the stomach, through the abdominal wall, or into a bronchus.

The case is treated by an early exploratory incision. The cavity may be drained through an incision in the epigastrium, or a counter-opening may be made on the left side behind and below the diaphragm, after the removal of a piece from one of the last ribs. The case when seen may have to be treated for an empyema, through which the subphrenic abscess may sufficiently drain or require another opening lower down.

Gastrotomy.

An opening into the stomach is required for the removal of foreign bodies, in the search for hæmorrhage, and in order to dilate the cardiac or pyloric orifices.

The stomach, whenever it can be done, is washed out completely just before the incision. The stomach is drawn forwards, and the abdominal cavity protected from contamination before the opening of the stomach.

The foreign bodies removed have been masses of hair from silly girls, a spoon, fork, knife, nails, etc., swallowed by lunatics.

The cardiac orifice may be dilated with the finger, or by passing a bougie upwards. A tooth-plate has been removed in this way after all attempts from the mouth had failed.

Simple Stenosis of the Pylorus — Pyloroplasty. — On opening the dilated stomach, the pylorus is found so narrow as only to admit a probe. Although rigid, yet signs of ulceration and of induration beyond the pylorus are absent, and this, with the longer duration of the affection, tends to exclude malignant disease. The pylorus can be dilated by bougies, and finally with the finger, but the stricture is apt to recur. It is better, therefore, to make a longitudinal incision completely through the whole thickness of the strictured pylorus, and then to suture the wound in the transverse direction (Fig. 80).

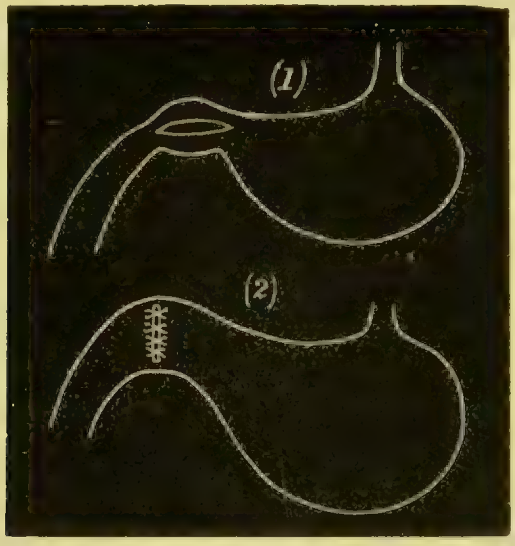


FIG. 80.—PYLORIC STENOSIS—PYLOROPLASTY.
(1) Line of incision; (2) line of suture.

Gastrorrhaphy.—When the stomach is simply dilated without pyloric stenosis, the organ can be reduced in capacity by tucking in folds and uniting them by suturing together the peritoneal surfaces.

Gastrostomy for Stricture of the Œsophagus.

Gastrostomy is the formation of a permanent fistulous communication with the stomach, through which food can be inserted directly. It is especially required for simple stenosis of the œsophagus, syphilitic or traumatic, which cannot be successfully dilated. It could scarcely be of use for a baby born with congenital occlusion of the œsophagus, for there is usually a communication with the trachea. It is also employed for malignant stricture of the œsophagus, but the indications for the operation are doubtful. In early cases of malignant disease of the œsophagus, temporary rectal feeding—so as to give rest to the œsophagus—gentle dilatation by bougie, or the introduction of a Symond's funnel through the stricture, suffice to relieve the œsophageal obstruction, whilst there is no evidence that gastrostomy delays either the rapidity of growth or perforation of the œsophagus, which is usually the fatal complication. If, on the other hand, gastrostomy is postponed until the patient is weak, the mortality following the operation is very great.

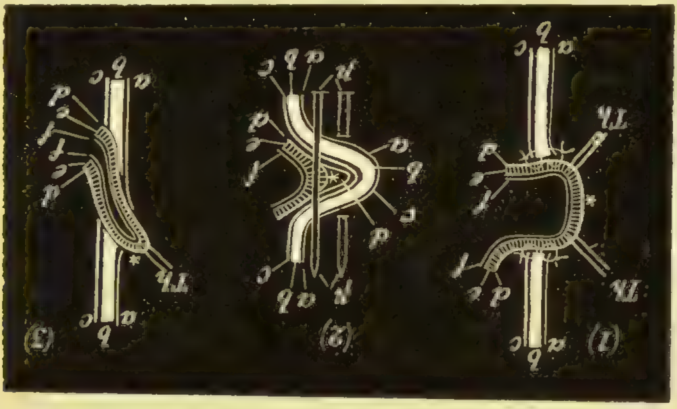


FIG. 81.—GASTROSTOMY.

(1) Double row of sutures; (2) hare-lip pins; (3) stomach drawn obliquely through wall: *a*, skin; *b*, aponeurosis and muscle; *c*, parietal peritoneum; *d*, visceral peritoneum; *e*, muscle coat of stomach; *f*, mucous membrane; *, point where stomach is opened; *Th*, *Th*, silk sutures for drawing out stomach; *p*, *p*, hare-lip pins passing through abdominal wall and sero-muscular coat of stomach.

Even if the operation is successful from the surgical point of view, the stomach may prove irritable, and reject the food introduced by the fistula.

The incision to expose the stomach is generally made parallel to, and immediately below, the left rib cartilages. The stomach is found contracted underneath the ribs, and is drawn forwards, so that the anterior wall, as near as possible to the cardiac end, is brought into the wound. Two silk sutures are inserted a short distance apart through the peritoneal and muscular coats, so as to mark the point for puncturing the stomach. Then the stomach is fixed to the abdominal wall in one of several ways (Fig. 81). The quickest plan consists in inserting two hare-lip pins through the edges of the abdominal incision, and taking up the stomach wall. The pins are inserted one on either side of the silk sutures, and by their insertion through the peritoneal and muscular coat truss the wall of the stomach forwards against the parietes. Adhesions form, and after a day or so a puncture with a tenotome is made between the sutures, into which a small rubber catheter is passed. The catheter is tied in position and clamped, to prevent regurgitation.

Instead of hare-lip pins, the stomach is sutured to the parietes by a double circular row of sutures.

A third plan consists in undermining the skin for about 1 inch at the side of the wound, making a small hole, and drawing through it the silk sutures. Thus a portion of the wall of the stomach is drawn obliquely through the abdominal wall, which then acts as a valve. The stomach can be opened at once, for the valvular opening prevents regurgitation.

After the operation the patient is supported by nutrient enemata, whilst fluid food is inserted through a rubber catheter from a funnel in small quantities. When the communication becomes well established, the patient learns to feed himself with fluid food. He may also masticate solid food, and then spit it into the funnel. It often happens that after gastrostomy the patient returns to swallowing by the œsophagus, and such cases illustrate the fact that swallowing often improves if temporary rest is given to the œsophagus by administering nutrient enemata.

Gastrostomy failures arise from shock to an exhausted patient; gaseous infiltration of the parietes and peritonitis; falling back of the stomach, and the leakage of its contents into the abdominal cavity; eczema of the skin, owing to irritating discharges from the stomach.

Malignant Stricture of the Pylorus.

Relief may be given in a case of malignant stricture of the pylorus by careful feeding, and by washing out the stomach at the end of digestion after a meal, before fermentation has time to go far. The pyloric orifice has also been dilated with the finger, and some of the growth scraped away, afterwards suturing the wound made in the wall of the stomach. The operation is not dangerous, supposing no rupture is occasioned. There are two other operations—excision of the pylorus and gastro-enterostomy—both of doubtful expediency.

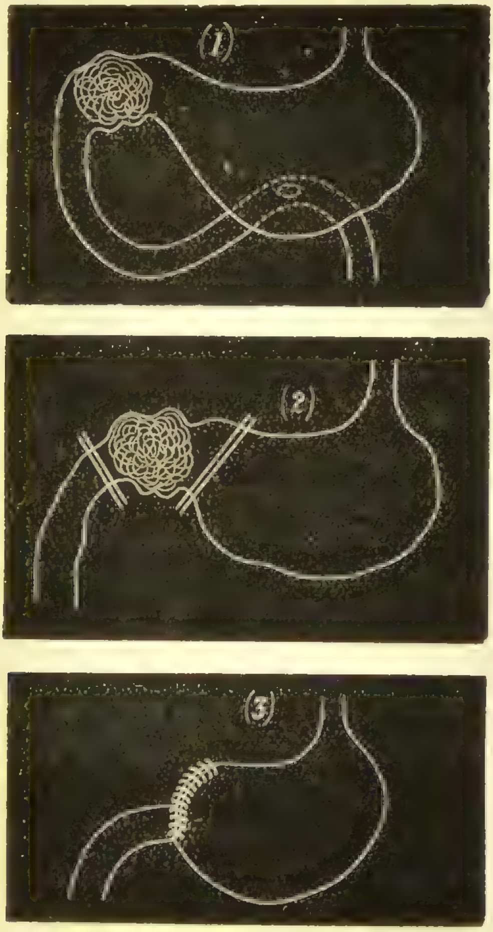


FIG. 82.—CANCER OF THE PYLORUS.
(1) Gastro-duodenostomy; (2) lines of excision, pylorectomy; (3) line of suture after pylorectomy.

Excision of the pylorus is a dangerous and difficult operation, which can only be undertaken early in the disease, when the gastro-hepatic omentum and neighbouring glands are entirely free from infiltration. Of those who have recovered from the operation, recurrence has taken place in nearly all the cases. Still, a few have been cured, and many much relieved for a year or two. The operation is at first exploratory, and can only be proceeded with when a circumscribed tumour is met with which is still freely movable, and not marked by extending into the mesentery. Simple fibrous stricture must be definitely excluded, and in cases of doubt the longitudinal division is made of the stricture, and a thin slice is cut off from the edge of the incision for microscopic examination.

The excision of the pylorus is begun by clamping the stomach and duodenum above and below the growth, either by the hands of an assistant or by long clamp forceps. The mesentery on either side of the pylorus is ligatured and cut away. In excising the tumour, the stomach is cut obliquely from above downwards, the duodenum is divided transversely. More of the mucous membrane than of the rest of the wall must be cut away, or it will bulge. After ligaturing bleeding vessels, the suture commences from the lesser curvature of the stomach, the edges of the stomach being brought together until the opening from the stomach is reduced to that of the cut end of the duodenum; then the stomach and duodenum are sutured together. (See Fig. 82 (2) and (3); also Chapter VIII., p. 93.)

Gastro-enterostomy.

As a palliative treatment for advanced malignant disease of the pylorus, an anastomosis is made between the stomach and duodenum, or first part of the jejunum. But it is a question whether, on the whole, life is prolonged by its means. It is a dangerous operation, which, even if successfully carried out, may fail owing to regurgitation from the intestine, or owing to closure of the newly-made opening. The operation is indicated only when careful feeding and washing out of the stomach, and also nutrient enemata, fail, and it is found that the pylorus cannot be excised or dilated. The stomach is emptied of its contents, a hole in the mesocolon is made, a loop of intestine clamped on either side is brought into contact with the lower and posterior surface of the stomach, and the anastomosis is made as described on p. 95; see also Fig. 82 (1).

SMALL INTESTINES.

Wound.—A punctured or lacerated wound is shown to have injured the intestines by the escape of fæcal material and gas from the wound.

A bullet wound of the abdomen should be explored under all circumstances, as soon as arrangements can be made for operating and for the after-treatment of the patient. The punctures are sought for by passing the gut systematically between the fingers. A bullet which takes an antero-posterior direction, if it misses the large vessels, generally does less damage than one which traverses the abdomen laterally. Although a few of the former cases have recovered spontaneously, they are only the exceptions to the rule. A number of perforations by revolver bullets have been united with success. If there is any delay, so that peritonitis commences, operative interference is practically hopeless.

Rupture.—Intraperitoneal rupture of the intestine takes place after an injury, and is shown by the collection of gas in the peritoneum, causing loss of liver dulness and a tympanitic note. Exploration and suture are the only means of saving life.

Intussusception (Fig. 83).

Intussusception is the involution of a segment of bowel into the gut below. It may be imitated by taking a coil of intestines in the thumb and finger of each hand, and pushing one into the other.

Intussusception occurs chiefly at the ileo-cæcal valve. The small intestine first passes through the valve, and the intussusception then increases at the expense of the large intestine. It is for the most part met with in young children, presumably from disturbances of digestion. Less often it is caused by some special condition, such as a polypus, impacted gall-stone, etc., and then may occur at any point.

An intussusception is such a common cause of intestinal obstruction in young children that its presence may be always expected in them when there is no sign of hernia. The special signs are a sausage-like lump in the abdomen, and the discharge of mucus and blood per anum. As the intussusception increases, the tumour travels round the course of the colon to the rectum, where it may be felt, or from which it may protrude. Left untreated, the patient dies of intestinal obstruction, or, as the intussusceptum or entering bowel commences to become gangrenous, perforation takes place at the junction with the intussuscipiens or sheath, so that the last stage of the disease is fæcal peritonitis. Occasionally the intussusceptum has sloughed away from the intussuscipiens or sheath, and has been discharged per anum partly digested. But survival in an untreated case is so rare that it must not be expected.

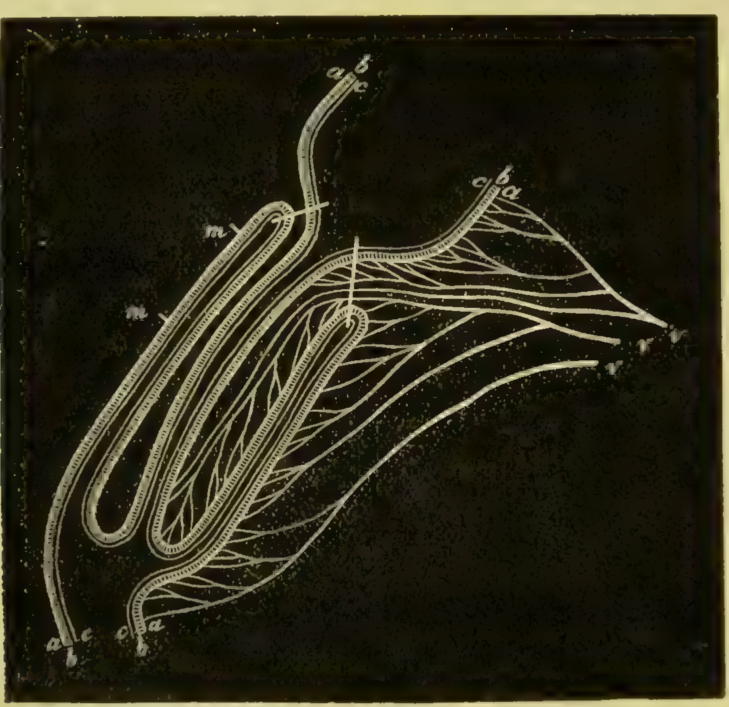


FIG. 83.—INTUSSUSCEPTION.

a, Peritoneum; *b*, muscle; *c*, mucous membrane; *v*, *v*, bloodvessels in mesentery; *m*, *m*, position of Maunsell's linear incision into the sheath or intussuscipiens for the removal of the intussusceptum at the level marked by the white lines. The latter also indicate the level of spontaneous separation.

Intussusception, if of less than forty-eight hours' duration, may be returned by the gentle distension of the bowel with water. The child should be chloroformed, and its pelvis raised above the head and thorax. The surgeon places one hand on the abdomen, and with the other squeezes in water through a ball syringe. The gut below the tumour distends with water; then the tumour should move back towards the cæcum, become reduced in size, and disappear with a gurgle. If much force is used, perforation will take place, and the method should never be tried after the disease has existed for more than two days.

The intussusception may not be completely reduced, the tumour never quite disappearing, or, having been quite reduced, it recurs (chronic intussusception).

In all except the earliest and simplest cases of intussusception, abdominal section must be at once done; then the entering bowel is gently withdrawn, and if it shows any sign of slipping in again, it may be fixed by suture to some suitable point of the wall.

If the gut cannot be withdrawn, the intussusception is excised. For this purpose Maunsell's plan is especially suitable. See p. 95.

Intussusception is a very fatal condition owing to delay in the adoption of the above measures. It is exceptionally a chronic affection, causing intestinal irritation, vomiting, diarrhœa, and exhaustion, without the gut actually being strangulated. The treatment consists in reducing the intussusceptum by a syringe and water, and in preventing its recurrence by regulating the action of the bowels. But the patient must not be allowed to become exhausted by repeated recurrence of the intussusception. The gut should through an incision be fixed in a suitable position to prevent this.

Perforation following Intestinal Ulcers.

Duodenal ulcers occur in men about forty, but the symptoms are indefinite. Perforation is attended by sudden collapse, gas in the peritoneum, and bilious vomiting, which does not become fæcal. The perforation is treated like that of the stomach, the perforation and ulcer are invaginated, and the peritoneal surfaces sutured.

Perforation of Ileum in the Course of Typhoid Fever.

The exhausted state of the patient, and the multiplicity of the ulcers—although only one may actually have perforated—renders success very rare. It is only when a perforation takes place early in the disease, whilst the patient is still strong, that any attempt at suture can be made. The edges are wiped with carbolic acid, tucked in, and the peritoneum sutured. Late in the fever the intestine is inflamed, perhaps adherent, and it is as easily torn as wet blotting paper. A small opening should be made, and a drainage-tube passed into the right iliac fossa, through which hot water should be gently irrigated; or the tube may be continued on through a counter-opening behind above the iliac crest.

Inflammation and Perforation of the Appendix Vermiformis.

Appendicitis.—Surgical measures are required in the case of appendicitis going on to suppuration and the formation of an abscess, in recurrent inflammation and thickening of the appendix, and when the appendix is gangrenous or perforated. The changes in the appendix are the only lesions known. Typhlitis is a clinical term for the symptoms produced by constipation. The pain has typically a sudden onset and may be at first widespread, referred to the umbilicus, to the loin, or to the groin. It is liable to be confused with nephralgia. The pain tends to be more and more localized by the patient at the outer border of the rectus, between the umbilicus and the anterior superior spine, and is attended by rigidity of the abdominal muscles and slight tympanites in the right inguinal region. There is fever and gastric vomiting. The patient should be put to bed, and given an entirely fluid diet, also an aperient or enema, or both, so that the bowels are moved. Belladonna extract or leeches and hot fomentations are applied locally. The alternative treatment has been to give opium to relieve pain. This is most objectionable, for it is impossible to know when suppuration or perforation has supervened, owing to the symptoms being obscured by the opium. Morphine injections give temporary relief, and a continuance of the pain indicates the need for an exploration.

A perityphlitic tumour next develops, due to effusion into the peritoneum behind and below the empty cæcum, which is pushed forwards so that the tumour is partly dull, partly tympanitic to percussion.

Perityphlitic Abscess.—Suppuration and the formation of an abscess in the ileocæcal peritoneal fossa are indicated by an increase of the induration of the abdominal wall along with œdema; and this tumour will become the more apparent when the patient is anæsthetized. Pain and fever increase; rigors may occur. The incision should not be delayed until fluctuation is perceived, for the general peritoneal cavity may be involved, or septic thrombosis of the iliac vein, or empyema, or pneumonia may arise.

The incision is made over the most prominent part of the swelling. Forceps are pushed into the abscess cavity and dilated. The pus is washed out and wiped away with the greatest care, or the peritoneum will be opened. It is better not to do anything to the appendix unless it presents; there should be no search for it, no breaking down of adhesions. When the abscess cavity is large, a counter-opening in the loin above the crest of the ilium is a great advantage. The pus may lie behind the cæcum or burrow into the pelvis. The patient should not get up too soon, and a special truss is required where the wall is weak, to prevent a hernia.

Recurrent Inflammation of the Appendix.—After two or more slight attacks of appendicitis, the appendix can be felt, between the attacks, to be enlarged. It is thickened by chronic or tubercular inflammation, kinked or distended by mucus and fæcal concretions.

The appendix is removed by a curved incision, commencing above and internal to the anterior superior spine, and ending ½ inch above and external to the middle of Poupart's ligament. When the peritoneum is reached, a small opening is made, the appendix is separated from any adhesions, and drawn out up to its junction with the cæcum, round which the peritoneum is sutured (Fig. 84). Having thus shut off the peritoneal cavity, the appendix is amputated by making a circular incision through the peritoneal and muscular coats. The appendix being pulled on, the mucous membrane is drawn out, and, having been tightly ligatured, the stump of mucous membrane retracts when the appendix is cut away beyond the ligature. Thus the peritoneal and muscular coats form a circular flap, which is sutured over the stump of mucous membrane, whilst the whole lies in the subperitoneal tissue. The parietal wound is sutured, and if primary union is obtained, no subsequent hernia of the scar need be feared.

Acute Gangrene of the Appendix.—Acute inflammatory gangrene is set up by the lodgment of a fæcal concretion or foreign body, along with the retention of mucus containing virulently septic bacteria. Boys are particularly liable to be attacked, sometimes after slight digestive troubles, or after an injury. The onset is sudden, and the course acute. The characteristic feature is the special position of the pain and tenderness above noted. The pain is constant, with sharp colic-like exacerbations. The abdominal wall is retracted, and the ileocæcal region rigid, but there is no tumour. Vomiting is repeated, and may be biliary, but not fæcal. Gangrene is marked on the second day, and perforation shortly follows. This must be anticipated by removing the appendix. If this is not done, perforation is likely to occur, at which there is a diminution of the local symptoms, and a fall of temperature, followed within a few hours by symptoms of general septic peritonitis, marked abdominal distension, fæcal vomiting, a dry furred tongue, shrunken face, cold extremities, and a rapidly-rising pulse. Except immediately after perforation the case becomes hopeless, the peritoneal cavity may be washed out, but the patient

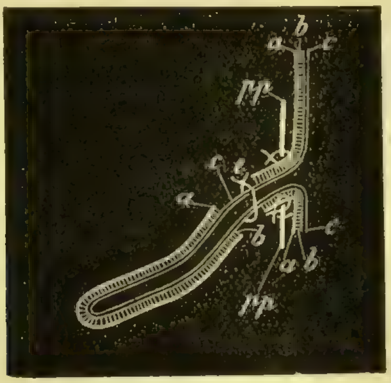


Fig. 84.—Excision of the Appendix.

a, Visceral peritoneum; *b*, muscle; *c*, mucous membrane; *p p*, parietal peritoneum sutured to sero-muscular coat of appendix; *e*, ligature of drawn-out mucous membrane of appendix after circular division of sero-muscular coat.

will not recover. Before this, excision of the appendix is practically as successful an operation as the one for recurrent appendicitis.

Meckel's Diverticulum.

Meckel's diverticulum may become distended to form a pedunculated cyst, and can be removed in the same way as the appendix.

The diverticulum may be perforated by a fæcal concretion or foreign body, and septic peritonitis takes place. The neck of the diverticulum is cut off, the edges turned into the intestinal lumen, and the peritoneal surfaces united. If, however, the neighbouring gut is involved, a segment must be excised.

A Meckel's diverticulum forms a hernia, external in the inguinal, femoral, or obturator rings, or internal through a hole in the omentum or mesentery. This gives rise to the symptoms of strangulation of a partial enterocele, viz., intestinal obstruction without constipation.

Under the band which a Meckel's diverticulum forms—whether this be due to its persistent connection with the abdominal wall behind the umbilicus, or owing to some acquired adhesion—a loop of bowel may slip and become strangulated.

An umbilical fæcal fistula forms when the diverticulum remains patent up to the umbilicus, and out of this mucous membrane may prolapse.

Malignant Disease of the Cæcum.

When the malignant disease is circumscribed, the cæcum is removed after uniting the ileum to the ascending colon. When the disease is too extensive for removal, only the anastomosis between the ileum and colon is carried out.

Drainage of the cæcum may be done for acute intestinal obstruction, *e.g.*, caused by malignant disease involving the ascending colon or the hepatic flexure.

LARGE INTESTINE.

Volvulus.—Volvulus is a twisting of the intestine commonly seen in the sigmoid flexure, and this form can be imitated by taking a loop of the sigmoid flexure and twisting it in the direction of the sun's course through 90°, 180°, etc. It may occur primarily, or complicate some other condition, such as a tumour. This causes intestinal obstruction, but there is nothing by which volvulus can be diagnosed beforehand. If recent it can be untwisted, failing which excision is required.

Colotomy,

or, better, **colostomy**, is done most commonly in the left inguinal region in order to relieve the obstruction caused by rectal cancer, but occasionally left lumbar, transverse, or right lumbar colotomy may be required. The chief difference in these operations from that to be described is the position of the incisions.

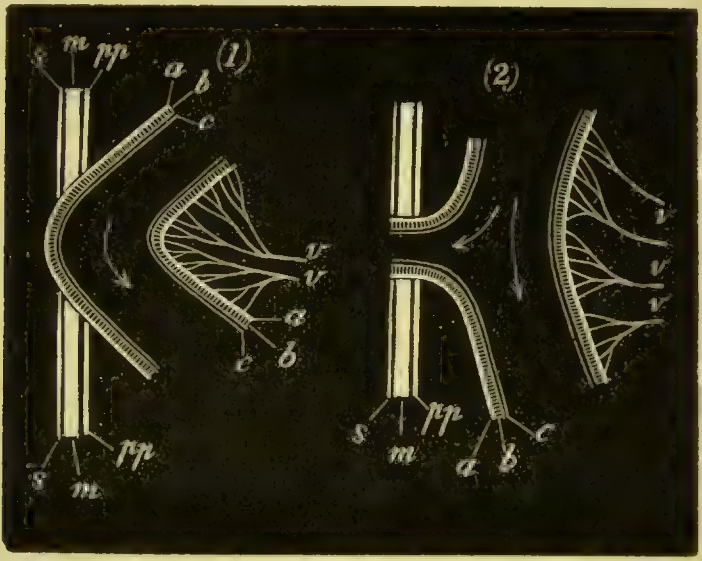


FIG. 85.—FORMATION OF A FÆCAL FISTULA.

(1) Loop of bowel fixed in abdominal wall—the lumen is unobstructed; (2) fistula complete, lumen unobstructed—contents may pass as before, or escape by fistula: *s*, skin; *m*, muscle; *p p*, parietal peritoneum; *a*, visceral peritoneum; *m*, muscle coat; *c*, mucous membrane; *v*, *v*, blood-vessels in mesentery.

Left Inguinal Colostomy.—This is by choice carried out in two stages: (1) The bowel is fixed to the abdominal wall. An incision is made at right angles to a line joining the umbilicus and anterior iliac spine. The incision, about 2 inches in length, crosses this line about 1½ inches from the spine. The incision being carried through the abdominal parietes, the sigmoid flexure, recognised by its thick wall and by its longitudinal bands, is sought for at the brim of the pelvis, where it joins the colon, and is drawn out, the small intestines and omentum, if they present, being pushed back. The highest part of the sigmoid flexure is selected, so that the descending colon is taut when the loop is drawn out. This loop is fixed in the wound by thrusting a rod through the mesentery, the ends of which rest on the abdominal wall on either side; there is then no possibility of the gut falling back, and a good spur is ensured. Sutures are hardly required, unless a long wound has been made, when it should be closed at either end. The bowel is covered by green protective and a dressing. Gauze must not be applied directly, otherwise the exudation will fix it. On inspecting the loop twenty-four hours after, a most plentiful coagulated exudation will be found covering the bowel. If there are any symptoms of distension, or immediately upon the patient vomiting, a transverse incision into the bowel is made with a dull-red cautery. This may be delayed for five days, if no signs of obstruction appear. In about ten days the loop is cut transversely across with the cautery until the

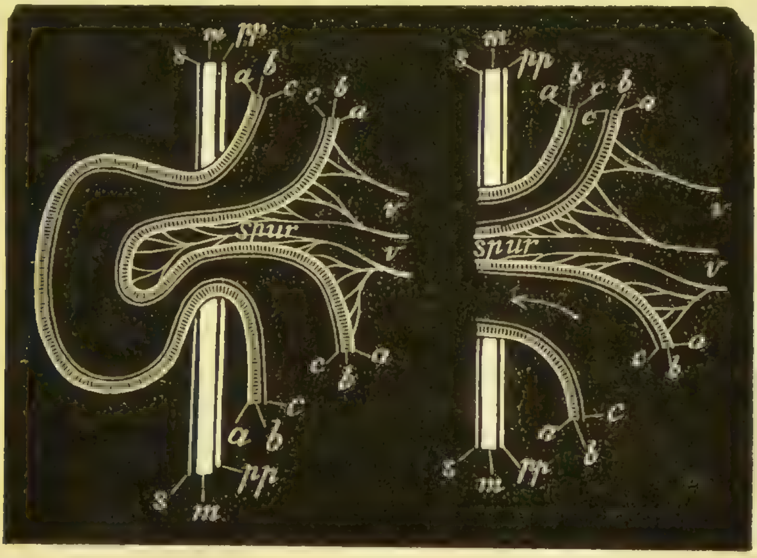


FIG. 86.—COLOTOMY, OR COLOSTOMY.

(1) Loop of bowel drawn out as far as the mesentery to ensure a spur; (2) colotomy completed—owing to the spur, all fæces must escape from the proximal end, whilst the distal end shrinks: *s*, skin; *m*, muscle; *p p*, parietal peritoneum; *a*, visceral peritoneum; *b*, muscle coat; *c*, mucous membrane; *v*, *v*, bloodvessels of mesentery.

rod is reached. At the moment of cutting into the mesentery a griping pain will be caused; otherwise the patient does not feel much, especially if a morphine injection is given beforehand. Slow division with the cautery at a dull-red heat generally arrests bleeding; ligatures are applied to spouting vessels. Redundant portions of the bowel are shaved off, avoiding the skin.

Where there is acute obstruction, the bowel may be fixed in the aforesaid way, and then a cannula tied in, and the fæces led through a tube into a vessel. By the time that the cannula ulcerates out the gut will have become adherent.

Before the patient gets up, a colotomy-truss is fitted, and the bowels are regulated so as to have one motion a day. As soon as good adhesions have formed, the lower bowel is washed through, and this may be continued if the patient finds relief.

Colotomy relieves a patient from obstruction and from the irritation of the growth by the fæces. It fails to relieve the pain caused by pressure of the growth on the pelvic nerves. Eczema of the skin around the colotomy wound is avoided by cleanliness, dusting powders, and by arresting diarrhœa. The prolapse and bleeding of the gut is prevented by pulling down the sigmoid flexure until it is taut, and by applying a truss before the patient gets up. The passage over of fæces into the lower bowel, or the retraction of the gut so as to narrow down the artificial anus to a fæcal fistula, is prevented by making a good spur between the upper and lower bowel in the way described. If the malignant growth involves the sigmoid flexure, the colotomy must be done in the descending colon.

Colectomy.

Excision of any portion of the large intestine may be done for malignant disease. It is best to do it in one operation, but when there is much distension at the time of operation the growth is cut away, an artificial anus made, and after the distension has passed off the opening is closed by a plastic operation.

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CHAPTER XXXI.

SURGERY OF THE GALL-BLADDER, LIVER, OMENTUM, MESENTERY, PANCREAS, SPLEEN, AND AORTA.

The Surgery of the Gall-Bladder.

The surgery of the gall-bladder includes incision (cholecystotomy) and drainage (cholecystostomy), as well as in the removal of gall-stones. The removal of the gall-bladder (cholecystectomy), and the union of the gall-bladder with the duodenum (cholecystenterostomy), are also occasionally required.

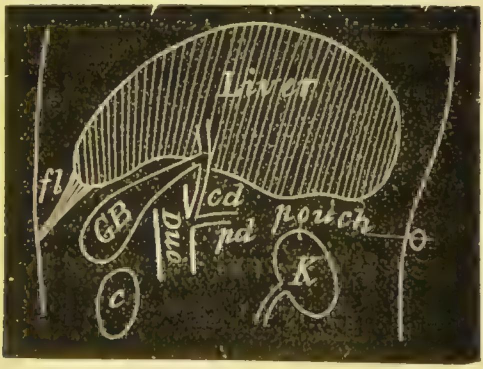

Fig. 87.—The Relations of the Gall-bladder.

G B, Gall-bladder and cystic duct; *c d*, common bile-duct; *p d*, pancreatic duct; *Duo*, duodenum; *c*, colon; *K*, kidney; *fl*, falciform ligament connecting with umbilicus; *o*, point for counter-opening draining kidney pouch.

The indications for surgical interference are as follows:

Distension of the Gall-Bladder.—The gall-bladder when distended is felt as a rounded tumour below the liver, moving up and down with respiration. If distension continues, it may burst into the peritoneal cavity, and this may be precipitated by some slight accident. Healthy bile is sterile, and does not at first set up inflammation; but if inflammation has preceded the rupture, acute peritonitis immediately ensues.

Recurring Biliary Colic.—Recurrent attacks of severe and exhausting pain, which cannot be prevented by medical means, afford a good reason for exploration, although no distension of the gall-blader may be felt. Calculi may be found, and removed from the gall-bladder, cystic duct or common duct.

Jaundice. — Persistent and marked jaundice with distension of the gall-bladder is generally due to malignant disease; but intermittent jaundice with attacks of severe pain points to a calculus in the common duct. The gall-bladder may be empty, and the intermittent attacks of pain and jaundice are explained as due to the calculi failing to completely block the common duct.

Inflammation and Suppuration.—Inflammation and its sequelæ result from the presence of stones, and also are secondary to various septic conditions. The gall-bladder may be distended with pus, empyema of the gall-bladder, when, in addition to the tumour formed, there will be fever. The gall-bladder ulcerates and perforates, and local septic peritonitis is set up in the pouch about the head of the kidney, or there is general septic peritonitis. The abdominal wall becomes distended, rigid, and inflamed below the ribs, the most painful spot being below the ninth rib cartilage towards the umbilicus. If the pus extends upwards into the bile-ducts of the liver (pyelophlebitis), the liver greatly enlarges, there is continuous fever with exacerbations, accompanied by rigors, jaundice, sweating and wasting, from which may follow general pyæmia before death.

Biliary Fistulæ (see Fig. 87).—When there is suppuration, and a localized abscess forms, the pus may burrow to the surface, and, after bursting, gall-stones may be discharged. The commonest place for this fistula is the umbilicus, extension having taken place along the course of the obliterated umbilical vein. The distended gall-bladder may communicate with the duodenum, and it is by this route, and not through the common duct, that the large gall-stones which cause intestinal obstruction gain entrance.

A communication has taken place with the pelvis of the right kidney, from which gall-stones have been removed. Also gall-stones have been discharged through the lung. A fistula may be kept open because the gall-bladder contains calculi, because the cystic duct is blocked, in which case the fistula discharges mucus, or the common duct is blocked, and all the bile escapes by the fistula, and none, or very little, enters the intestine.

Intestinal Obstruction is a secondary consequence of gall-bladder disease determined by the local peritonitis, the distension of the gall-bladder, or the blockage of the intestine by stones, which have reached it through a fistula from the gall-bladder.

Cholecystotomy—Cholelithotomy.

The gall-bladder is to be emptied only through an incision. Aspiration through the abdominal wall is dangerous and of no use. The patient is placed on the back with a sandbag behind the liver, so as to bring forwards the gall-bladder and ducts, whilst the intestines tend to slip downwards. The incision is made vertically in the linea semilunaris. It can be enlarged by a transverse incision outwards (Fig. 75, p. 319), when more room is required, whether on account of the thickness of the wall, or on account of the depth of the common duct. Bleeding may be troublesome where the patient is jaundiced, and a good many ligatures be required. When the abdomen is opened, the rest of the abdominal cavity is protected by sponges, and then the gall-bladder is aspirated, drawn forwards, and incised. The interior is explored by the finger, and the cystic duct by a probe. Calculi are removed with forceps or scoop, or crushed. A stone in the cystic duct may be seized with forceps, crushed or pierced with a needle to make it break up, and the fragments squeezed out. The manipulations inside the bladder are aided by a finger outside. A non-perforated tube is put into the gall-bladder, and after cleansing any part of the peritoneal cavity which has been soiled, and removing the sponges, the edges of the gall-bladder are united to the parietal peritoneum and aponeurosis. The tube is kept in until the discharge becomes small, and is formed of only normal bile and mucus. If the common duct is patent, the fistula will close by the union of the skin when the tube has been removed. Hence the gall-bladder must not be sutured to the skin.

When the gall-bladder is small and contracted it may be impossible to bring it to the surface. If the gall-bladder has been partly destroyed by ulceration or gangrene, there is in addition local septic peritonitis extending into the right kidney pouch. In such cases the parietal peritoneum and the omentum may be so sutured as to shut off the rest of the peritoneal cavity. A non-perforated rubber or glass tube is inserted into the retracted gall-bladder and surrounded with gauze. Or the contents of the gall-bladder may be allowed to escape into the local peritoneal pouch, which is drained either by a tube in the outer end of the transverse incision, or a tube is passed into the most dependent part through a counter-opening made behind, and then the anterior addominal wound can be closed (Fig. 87, p. 371).

Choledochotomy.

When the gall-bladder and cystic duct have been cleared, and it is found that the common duct is blocked by calculi, it may be possible to crush them by means of the thumb and finger, and then move on the fragments into the duodenum. When, however, this cannot be done, the stones may be removed through an incision.

A large opening is required, the stone in the duct is grasped with thumb and finger and drawn forwards into full view, so as to avoid the portal vein. The peritoneum is likewise protected by sponges. Then the common duct is incised longitudinally, the calculi removed, and the duct afterwards united by a continuous suture through its peritoneal and muscular coats. A stone close to the duodenum or the lower end of the duct has been released by reaching it through the duodenum. When the patency of the common duct cannot be restored, whether on account of the difficulty of removing the calculi, or on account of the stricture to which the calculi have given rise, cholecystenterostomy is done.

Closure of a Biliary Fistula—Cholecystectomy.

When a biliary fistula is kept up by calculi difficult to remove, an attempt to dissolve them may be made by injecting olive-oil, or sapo animalis 0·5 per cent. solution, or turpentine dissolved in ether.

If the common duct is patent, the gall-bladder may be separated from the peritoneum, until the cystic duct is reached, around which a ligature is tied and the gall-bladder cut away.

Cholecystenterostomy.

The gall-bladder is united to the intestine, preferably to the duodenum, when the obstruction of the common bile-duct cannot be removed. In cases of malignant disease obstructing the duct, temporary relief may be given owing to the bile again entering the intestine; on the other hand, the operation cannot be much service late in the disease.

The operation is best performed by the aid of Murphy's button. The gall-bladder is emptied by aspiration, an incision made two-thirds of the diameter of the button, a running thread is passed through all the thickness of the wall, the female half of the button is inserted, and the ligature tightly tied round its central cylinder and cut short. A loop of the duodenum is next emptied and clamped on either side. A running thread is inserted through all the coats round an incision of a similar length. Into this is inserted the male half of the button, and the thread tied in the groove of the flange. On pressing the two halves together, the approximation is generally good, but supporting seromuscular sutures may be inserted where necessary.

Surgery of the Liver.

Wounds and Ruptures.—Venous blood flows profusely from a punctured wound of the liver. The wound in the abdominal wall is enlarged, and that of the liver closed by deep sutures or plugged firmly with gauze, which is withdrawn the next day. If there is then no sign of further bleeding, the abdominal wound can be closed.

A rupture of the liver is due to a crush, and causes rapid and acute anæmia, with the collection of fluid (blood) in the abdominal cavity. If there is also a lacerated wound of the abdominal wall, the diagnosis is easily made. The indications for operation in the case of a rupture of the liver without external wound must always be doubtful. A steady increase of the anæmia and of the fluid (blood) in the abdomen points to it as a necessity. The rupture of the liver is treated by approximating the torn surfaces by deep sutures. When a piece is quite separated, the lacerated surface of the liver is isolated by stitching the parietal peritoneum all round it and dressing the surface with gauze.

Tumours of the Liver.

Pedunculated adenomata and gummata have been successfully removed. The stump may be treated by the extra-peritoneal method just described for rupture. If it is sufficiently tough, an intraperitoneal pedicle ligature is substituted.

Hydatid Cyst of the Liver.

A slow and painless enlargement of the liver, unaccompanied by other important symptoms, such as jaundice, loss of flesh, or fever, suggests the diagnosis of hydatid cyst. And this diagnosis becomes more certain if a very tense elastic swelling can be felt below the ribs. The diagnosis must be completed by a small incision. Aspiration should be entirely discarded; it has been immediately fatal in at least 20 per cent. of the cases, and fails to cure in at least half. The fatal results are due to the extravasation of fluid under high tension beside the needle into the surrounding tissues, also to the puncture of a vessel which bleeds into the cyst as fast as the fluid is withdrawn. The operation must be undertaken before inflammatory complications have come on. The incision is generally made just below the ribs. When, however, the cyst extends up and encroaches upon the pleural cavity, the operation must be done behind across the pleura.

Anterior Operation.—The abdomen is opened by a small incision and the finger inserted. A cyst is felt projecting, or some portion of the liver feels much more tense than the rest. The wound is sufficiently enlarged, the edge of the ribs may be chipped away, and the peritoneal cavity is shut off by sponges. A small trocar and cannula are plunged into the cyst, and as it collapses the wall of the cyst is drawn forwards by cyst forceps and incised. The white parasitic cyst is separated from the surrounding adventitious cyst by inserting the nozzle of an irrigator, which detaches the parasitic cyst intact, floats it towards the surface, and renders the removal easy. A parasitic cyst separates with the greatest ease when inflammatory complications have not occurred beforehand. Instead of a single cyst, there may be a number of daughter cysts ; or the contents may have become semi-solid, then a blunt spoon aids in the evacuation. The adventitious cyst is well washed out, closed by suture, and dropped back, and the sponges are carefully removed, so as to prevent any escape of daughter cysts into the peritoneal cavity.

When the cyst lies beneath the surface of the liver, the most tense spot is selected, packed round by sponges, and a trocar and cannula inserted and the fluid drawn off. When the cyst is a good distance from the surface, the cannula is withdrawn and the puncture closed by a suture, or the cavity may be well washed out through the cannula first of all. If the cyst is but a short distance from the surface, the track of the trocar can be dilated by forceps, and the parasitic cyst removed as described above.

When a hydatid cyst suppurates, the treatment is the same as that of an abscess.

The *Posterior Operation* consists in cutting down upon the eleventh, also the tenth or twelfth rib, removing a length, incising the pleura, seizing the diaphragm, and suturing it to the pleura of the upper edge of the wound so that the pleural cavity is shut off, cutting through the diaphragm below the line of sutures, and exposing the upper and back part of the lobe of the liver. The lung only collapses a little when the pleura is opened, and soon re-expands upon closure (Fig. 73, p. 294).

Hepatic Abscess.

The abscess of the liver suitable for treatment by surgery is the single tropical abscess commonly following upon dysentery, but also met with in patients exhausted by malaria only.

The pus contains amœbæ, but when uncomplicated there are no pyogenic organisms. The symptoms of an abscess are the continuance of the fever with intermittent rigors, profuse sweats, progressive debility, but with only slight or no jaundice. The liver enlarges, and the abscess may come to the surface and cause fluctuation below the ribs. It may give rise to an empyema or discharge into the lung. In the case of unfavourable symptoms, exploration should not be delayed for fluctuation to appear.

Aspiration without incision is a very unsatisfactory means of diagnosis. If the pus is near the surface it is needless, and only causes delay in instituting drainage. If the abscess is deep, it is much safer to expose the liver first of all, otherwise pus is in danger of being extravasated on withdrawing the needle.

The abdomen is opened, and, unless the peritoneum is adherent, sponges are packed round and the abscess aspirated. If the abscess is deep-seated, along the aspirating-needle is passed the blade of a thermo-cautery at dull-red heat, and into the cavity is pushed a large tube without side-holes. The cavity is washed out with water, so as to remove the chocolate-coloured pus and sloughs, and the tube outside the liver is packed round with iodoform gauze and the sponges withdrawn. If the abscess projects from the surface of the liver and is small, a wide opening is made, pus and sloughs sponged out, after which the cavity is filled with iodoform gauze, and the end brought out through the abdominal wall.

A similar operation to that described for hydatid cyst can be done across the pleura.

A single hydatid cyst may suppurate, but it differs from the tropical abscess in containing pyogenic germs. The remains of the parasitic cyst should be got out if possible.

The removal of all pus and sloughs from the abscess cavity allows of a weak patient immediately commencing convalescence. By extension a hepatic abscess causes an empyema. On exploring the empyema a hole may be felt through the diaphragm into a liver abscess. A tube must be passed in and the cavity washed out. Multiple abscesses of the liver are caused by gall-stones (*q.v.*). Pyæmic abscesses are also multiple, but are not likely to afford opportunities for surgical treatment.

Surgery of the Omentum.

Omentum chiefly comes under the notice of the surgeon by forming a portion of the contents of a hernial sac, and by adhesions which have to be separated in the course of abdominal operations. The important point is the application of the ligature so as to leave no vein free to bleed.

The omentum becomes adherent to the back of abdominal incisions, and if a loop of intestine slips beneath, strangulation and symptoms of intestinal obstruction may ensue.

Movable tumours in the centre of the abdomen, not covered by intestine, may prove on abdominal incision to belong to the omentum. It may be found matted and rolled together by inflammation. A cyst may occupy it, an angiomatous or a fibrous tumour, or the tumour may be malignant. In the latter case, supposing the tumour to be confined to the omentum, the whole must be excised as completely as possible.

Surgery of the Mesentery.

The obstruction of one of the large branches of the mesenteric arteries inevitably leads to gangrene of the portion of bowel supplied, owing to the imperfect anastomosis. Hence the only operative procedures on the mesentery which are not accompanied by resection of the bowel are done upon encapsuled tumours, especially cysts.

A cyst of the mesentery is due to a dilated lacteal, and contains chyle, or is a hydatid cyst, or is a dermoid or other cyst which has become detached from the ovary and transplanted. There are also blood and serous cysts of the mesentery, probably of traumatic origin. The special signs of a mesenteric cyst are free mobility of a tumour covered by resonant bowel. Abdominal exploration is done for a tumour, or there may be also symptoms of obstruction.

The cyst may be dealt with by incision, washing out, and closure; by enucleation, and, only when absolutely necessary, by incision, suture to the abdominal wall, and drainage. It is of the first importance not to injure or be forced to ligature any considerable mesenteric vessel.

Multilocular cysts, tumours, etc., are not touched unless the corresponding piece of bowel is also excised.

Pancreatic Cysts.

The only affection of the pancreas which is amenable to surgical treatment is a cyst, and it should be incised and drained before suppuration sets in. A deeply-seated fixed abdominal tumour covered by intestine is found in the epigastric and umbilical region. As it enlarges, fluctuation may be felt. It must be distinguished from an aneurysm. An exploratory incision is made, the wall of the cyst exposed without injury to the mesentery; the rest of the peritoneal cavity is shut off by sponges. Then the cyst is aspirated, the wall drawn forwards and sutured to the parietal peritoneum. The cyst cavity is next incised, washed out, and drained with gauze strips or a tube. It is hardly possible to excise the cyst wall, and immediate closure might lead to recurrence owing to the distension by pancreatic secretions. The drainage-tube is left out after a few days, except when suppuration has already commenced, when it will have to be kept in longer.

Surgery of the Spleen.

Injury.—A lacerated wound of the abdominal wall and spleen may be followed by a prolapse of the spleen through the parietal wound. If so, the veins are compressed, and, in consequence, the spleen swells to an enormous size. If there is a punctured wound, bright arterial blood escapes. When there is no external wound, the symptoms are collapse, acute anæmia and the collection of fluid (blood) in the abdomen—especially in the left hypochondrium—and the continuance or increase of these symptoms is the indication for operative interference.

After injury, lacerations can be drawn together by deep sutures; then the spleen is washed and returned. If this cannot be done, the spleen is excised.

Abscess of the Spleen.—The abscess points in the left hypochondrium.

Movable Spleen.—Excessive mobility of the spleen may be brought under attention owing to the formation of an abdominal tumour, or owing to a torsion of the pedicle causing a great swelling from venous congestion. If the twist can be undone, the spleen is fixed in position by sutures. Otherwise the spleen is excised.

Splenectomy—Removal of Enlarged Spleen.

The removal of an enlarged spleen becomes desirable because it forms an abdominal tumour, increasing in size, or, at least, not diminishing. In addition, there may be cachexia.

The condition which is an absolute bar to surgical interference is leukocythæmia, for all torn adhesions bleed most freely, and recurrent hæmorrhage takes place from the stump. Indeed any extensive inflammation around the spleen, forming firm adhesions, renders excision dangerous. A chronic enlargement of the spleen, accompanied by cachexia, but not by leukocythæmia, is favourable for excision, and the patient recovers rapidly from the cachexia. Primary splenomegaly, fibro-cystic and other tumours, are also favourable cases for excision. Primary sarcomata of the spleen are only amenable to surgical treatment when growing slowly. The secondary affections of the spleen by carcinoma and sarcoma are to be left alone. A large vertical incision is made over the tumour, which is explored by the finger, so that very dense adhesions and malignant growths extending beyond the organ can be discovered, and the operation stopped. When it is decided to go on with the removal, the tumour is brought out through the wound and the pedicle tied, or the pedicle and adhesions can be all separately divided before bringing out the tumour; or, in special cases, the pedicle and all the adhesions are securely clamped, the tumour cut away, and then ligatures applied.

It is most important to tie the pedicle tightly, and not to let any vessel slip from its grasp. As further security, every vessel can be separately ligatured on the face of the stump after cutting the tumour away. All adhesions must be secured; also broad surfaces left by separating adhesions must be covered by suturing over them the adjacent peritoneum. Recurrent hæmorrhage is the complication to be avoided.

The Abdominal Aorta—Obstruction.

When a thrombus or an embolus blocks the abdominal aorta, a sufficient blood-supply may be restored by anastomosis. When the obstruction is sufficient to block the anastomosing vessels also, gangrene is inevitable.

Partial obstruction of the abdominal aorta is a cause of intermittent cramping pain, rigidity and paresis coming on especially after the commencement of exertion, such as walking. It may thus serve as a warning that complete paraplegia and gangrene may ensue if the obstruction increases.

Abdominal Aneurysm.

Abdominal aneurysms commonly occur on the main artery, but are occasionally met with on the branches. An aneurysm of the hepatic artery has obstructed the bile-duct and caused jaundice. Aneurysm or thrombosis, when it involves the superior mesenteric, which is an 'end artery,' inevitably produces gangrene of the small intestine, whether the whole or any one of the branches is involved. The symptoms are those of intestinal obstruction, with rapid collapse. Aneurysm of the renal artery has been caused by a spiked calculus, and bursting may take place either into the ureter or into the peritoneum. An aneurysmal varix has been seen on the spermatic artery. Aneurysm of a lumbar artery bulges back into the loin.

The aneurysms which involve the aorta itself may be distinguished into those which involve the bifurcation, and in which, therefore, there is a stretch of normal vessel above, and those in which the bulging is in the epigastrium. In doubtful cases the bowels require to be cleared out, and an anæsthetic must be administered before the expansile pulsation of the swelling can be definitely established.

Surgical measures are immediately dangerous to life; no method has got beyond an experimental stage. In any case, therefore, medical treatment must first be given a full trial.

The safest surgical procedure is to make a small opening into the abdomen and explore with the finger. A circumscribed sacculated aneurysm being found, needles may be inserted after MacEwen's method, so as to scratch the inner wall of the sac, or silver wire may be passed into the sac through a hollow needle. It is conceivable that some small aneurysms—situated on the branches—may be treated by proximal ligature. Compression of the abdominal aorta on the proximal or distal side of the aneurysm has been tried by applying it through the abdominal wall, but the method is entirely inexact, and hastens the patient's death, either by injuring the aneurysmal sac, the intestines, or the pancreas.

Compression of the Abdominal Aorta is sometimes useful in checking post-partum hæmorrhage, also during operations about the hip or pelvis. It is most easily applied by standing on a stool beside the patient, and employing the weight of the body to compress the vessel through a straight arm and closed fist.

A large screw tourniquet is used by applying the pad just below and a little to the left of the umbilicus. The vessel is first compressed by the fingers until pulsation is lost in the groin; then the pad is applied and held while the tourniquet is screwed up. It must not be applied more tightly than is just necessary to stop pulsation in the femorals. Harm is likely to ensue if the tourniquet is applied above the umbilicus.

Ligature of the Abdominal Aorta.—The abdominal aorta can be ligatured through the peritoneum in animals such as the dog or monkey, so long as the ligature is applied below the renal arteries. The animal recovers, and is none the worse. In rabbits, in which there is a poor anastomosis between the internal mammary and deep epigastric arteries, some rigidity and paresis of the hind-limbs may follow. Sir Astley Cooper, after experimenting on animals, ligatured the abdominal artery in a man for an aneurysm of the common iliac, which had burst. Other attempts have been made following this example, and have been nearly successful. The anastomosis after ligature of the aorta above its bifurcation appears to be good.

CHAPTER XXXII.

SURGERY OF THE KIDNEYS.

WHEN the kidney is not above the normal size it cannot be felt with any degree of certainty. Even in thin women with weak abdominal walls, and relaxed still more by an anæsthetic, the outline cannot be made out exactly; for the kidney lies surrounded by soft fat and loose connective tissue well under cover of the ribs. When, however, the kidney shifts its place, whether it floats in the abdominal cavity, or slips up and down behind the peritoneum, it can be felt, although of ordinary size. When moderately firm pressure upon the kidney is a cause of pain, or of a sickening sensation, some diseased condition is present.

Pain, the cause of which is in the kidney, may be referred down the ureter to the groin and into the testicle, which may be tender or drawn up spasmodically. This is due to the nerves conducting painful sensations from the kidney being connected with the spinal cord at the level of the lowest dorsal and highest lumbar roots.

When the kidney is enlarged it becomes evident, its shape can be made out, it does not move with respiration, and the colon lies in front of it, as may be shown by inflation per rectum.

The kidney of the two sides may be examined by the hand in the abdominal cavity, or through an incision in the loin. An enlarged or shrunken kidney may be thus recognised; it may be found to have become a cyst or abscess cavity, a stone may be felt lodged in the pelvis or ureter. A horseshoe kidney, *i.e.*, a fusion of the two sides in the middle line, or dilatation of the ureters, may be thus detected.

The healthy condition of one kidney, and its capacity to do the whole work, are established by collecting urine from the one kidney, which is poured into the bladder when the opposite ureter has become blocked, or when all the urine of the diseased side drains away through the loin. The outflow of urine into the bladder has been observed by the cystoscope, and jets containing pus or blood seen to come from one ureter and not from the other. The ureters have been catheterized, especially in the female, guided by the cystoscope or by the fingers in the vagina.

Injury.

Contusion.—A blow or squeeze causes pain in the loin, with a sickening sensation ; the patient may faint or vomit ; blood is found in the urine. A kidney so injured may remain tender, become cystic ; the blood-clot may form the nucleus of a calculus, or the extravasation of urine may occasion a perinephritic abscess.

Lacerated Wound of the Kidney with or without Prolapse.—The parietal wound is retracted, the laceration in the kidney sewn up by passing deep sutures through the kidney substance, the organ is washed and returned into position. When much smashed it may be excised.

Punctured Wound or Bullet Wound of the Kidney.—Severe hæmorrhage may result and blood collect either in the peritoneum or in the perinephritic tissues. Hæmaturia may be present or absent. The wound is exposed and closed by deep sutures, bleeding vessels are tied, all blood-clot, which would otherwise soon decompose, is cleared out, and the wound finally drained. When, however, the bleeding cannot be arrested by deep sutures or ligatures, nephrectomy is required.

Nephrorrhaphy, or Fixation of a Movable Kidney.

The kidney becomes movable in women as a consequence of pregnancy or of tight-lacing, or of both. The kidney floats freely in the abdominal cavity, attached by a long meso-nephros, or slides up and down behind the peritoneum in a track resembling a large tendon sheath. The signs are those of a movable abdominal tumour, which can be pushed back into the place of the kidney. The symptoms caused are pain, nausea or vomiting, sweating. The kidney may suddenly increase, owing to a kink in the ureter, causing hydronephrosis, and again return to its usual size at the same time that the bladder is suddenly filled with urine. Acute symptoms resembling strangulation of the intestines may be caused by torsion of the meso-nephros. When nephrorrhaphy is required, deep sutures are passed through the capsule and cortical substance, which enable the surgeon to draw back the kidney and fix it to the muscular edge of the wound. In slight cases, which can be returned into position, the patient rests for a few days in bed, and then gets up, wearing a belt with a soft pad over the position of the kidney.

Hydronephrosis.

The kidney is distended with urine of low specific gravity, and containing little urea. The pelvis may be simply dilated; some of the cortical kidney substance may be more or less completely destroyed by the distension to a thin-walled cyst. Hydronephrosis is due to a congenital obstruction of the ureter, also to a kinking of the ureter, so that hydronephrosis is apt to alternate with rapid disappearance of the tumour, owing to the escape of the urine into the bladder. The fluid withdrawn by an exploring syringe is found to contain urea, and no hydatid hooklets. A stone may lodge and block the ureter without causing suppuration. Rest, gentle massage, or aspiration may empty the tumour, but it is apt to refill. Nephrotomy should be done, and if a stone can be got away, or a movable kidney be fixed, the ureter may again become patent. But when the kidney has been reduced to a mere cyst, excision is done after ligature of the pedicle.

Renal Calculus—Nephrolithotomy.

The general causation of stone in the kidney is attributed to the uric acid diathesis, or to the water in districts where stone in the bladder is common. Frequently blood-clot after an injury or some inspissated mucus forms the nucleus. Congenital malformations of the kidney are often complicated by calculus.

A stone may form in a calyx, and never give rise to any symptoms, and be only discovered post-mortem. When, however, it moves down into the pelvis of the kidney, and is grasped by the commencement of the ureter, the symptoms of renal colic supervene. Following upon an attack of pain, the stone may be passed into the bladder, or lodge in the ureter, or return back to its place of formation in the calyx when the patient lies down and rests.

The changes which the kidney undergoes vary much, and no sufficient explanation can be given of these variations. When the stone gives rise to no symptoms, only slight sclerosis takes place in the wall of the cavity. A kidney may atrophy over a stone, until all that remains covering the stone is the thickened capsule. A change of the opposite kind is hydronephrosis, in which the kidney is equally atrophied, but distended to a cyst. Pyonephrosis is another result of a stone, also malignant disease.

The signs of stone are pain in the kidney, or referred to the back, down the ureter, to the groin, or testicle, corresponding to the distribution of the nerves coming off from the lowest dorsal and highest lumbar nerve roots.

This pain is increased by pressing on the kidney. Intermittent attacks of great pain occur, spreading from the loin round to the umbilicus, and attended by sweating, nausea, vomiting, and collapse. The urine, unless the ureter is blocked, contains albumin, blood, or pus. The diagnosis of the presence of stone is, however, uncertain, for in half the cases which have been operated upon no stone has been found. Slighter symptoms of renal colic may be produced by collections of urates in the pelvis and calyces of the kidney, which can be washed out by diluting the urine. Therefore the patient should first of all take boiled or distilled water in large quantities, together with diuretics, to see whether relief is given. The pain is often bilateral, and then the doubt arises whether there are really concretions in both kidneys, as is generally the case, or whether calculi in one kidney set up pain which is in addition referred to the kidney of the other side.

If there is hydronephrosis or pyonephrosis causing a swelling, the diagnosis may be rendered comparatively easy. If the urine in the bladder can be made clear, and then the mouth of the ureters examined with the cystoscope, a jet of blood may be seen being discharged from the suspected kidney. The kidney to which the symptoms mostly point may be explored through an incision in the loin, the kidney examined directly by the fingers, or punctured in several places; or the pelvis is opened by an incision, and the calyces and ureter explored with a probe. If no stone is found, the kidney may be drained, for relief follows the discharge of urates. The calculi are composed of urates, less commonly of oxalates. Both kidneys may be palpated from the peritoneal cavity, either through an incision in the loin or in the middle line; but, as a matter of fact, little may be learnt in this way, for the finger in the peritoneal cavity has the sense of touch much blunted by having to feel through the peritoneum and subperitoneal fat. Even if a stone can be felt, the peritoneal wound has to be closed before the removal of the stone can be proceeded with. Moreover, in many cases both kidneys have undergone extensive atrophy, owing to calculi, and the simple exploration of the peritoneal cavity is in danger of causing shock and suppression of urine. It is best, therefore, to confine one's self to lumbar nephrotomy, on one side first, after which, if the symptoms still continue, the operation is repeated on the opposite side.

Pyonephrosis—Suppurative Pyelitis.

The kidney is distended to form an abscess cavity, and the pus may spread and cause a perinephritic abscess; or the kidney does not enlarge, but the gland substance is destroyed. Pyonephrosis is usually caused by stone, suppurative pyelitis by extension from the bladder up the ureter, or from other pelvic organs. The signs are those of an abscess in the kidney region, with or without alkaline phosphates and pus in the urine, according as the ureter is patent or no. Pyonephrosis is treated by nephrotomy and drainage. If a renal fistula afterwards forms it can be scraped. Nephrectomy is undertaken when it has been shown by the urine reaching the bladder that the opposite kidney is healthy.

Tubercular Disease of the Kidney.

This disease occurs in young subjects likely to be affected with tubercle. The first sign is the occurrence of pus in acid urine, and tubercle bacilli are found in the deposit. Local signs of disease may be absent, and are always obscure. Suppuration may occur on one side, or the formation of a tumour. In primary tuberculosis symptoms of renal colic should be absent, also any previous urethral, bladder, or pelvic affection; also the patient should be young. But a secondary tubercular affection may complicate other diseases, such as septic inflammation spreading from the bladder. In half the cases the disease is bilateral. If the signs of disease are mainly on one side, nephrotomy is done and the urine drained away; then the urine of the opposite kidney can be examined. Supposing this urine shows the second kidney to be healthy, the diseased kidney is excised.

Suppression of Urine.

Suppression of urine is important to the surgeon for three reasons: It may be caused by calculous disease of both kidneys, and nephrotomy and drainage on one or both sides has relieved the patient. It is also due to the pressure effects originating from a stricture of the urethra. Immediate steps must be taken to relieve this by draining the bladder. It has been proposed that nephrotomy should also be done in such cases to relieve a congestion of the kidney, but this is questionable. For the suppression due to calculus blocking both ureters can only be relieved by mechanical means, whereas medical treatment is frequently successful in relieving suppression due to renal congestion, even after it has lasted three or four days or more. Suppression may also happen owing to a single kidney, and the same principle applies. If the suppression is owing to the mechanical obstruction of a stone, nephrotomy is required; otherwise the administration of purges, diaphoretics, and abundance of water is all that can be done.

Nephrotomy.

The patient is placed on the opposite side across sandbags, so as to widen as much as possible the distance between the ribs and the crest of the ilium. An oblique incision 3 or 4 inches long is made parallel to and just below the last rib. After dividing the aponeurosis, the muscles are separated with the finger and retracted, and only divided by the knife to as small extent as possible. The kidney fat is torn through by forceps, and the kidney being pushed outwards by the assistant pressing on the abdomen, the pelvis is opened by a short, longitudinal incision, and the wound dilated by forceps and the fingers. After the removal of stones, concretions, pus, etc., a drain is inserted, and the anterior part of the wound closed.

Nephrectomy.

Primary nephrectomy is chiefly required when the kidney is occupied by a tumour. Tumours of the kidney are relatively frequent soon after birth and in young children. They are rarely seen in middle life, but are met with occasionally in old people. Tumours of the kidney in children are congenital cystic tumours, sarcomas, or mixed growths.

A congenital cystic kidney may be so large at birth as to offer obstruction to labour. It may form rapidly after birth, or its enlargement may take place at a much later period. It may consist of a single cyst, congenital hydronephrosis, or be multilocular, with intercystic fibrous tissue. If unilateral, and no sarcomatous material is found in the tumour, the prognosis after removal is favourable. Even if a cystic tumour remain stationary under observation, its removal is advisable, as malignant features are likely to develop later. Unfortunately, the disease is often bilateral, and so any operation out of the question.

Malignant sarcomas occur in children—especially girls—

and form soft solid tumours, or are partly cystic; or a tumour which has apparently been cystic and benign becomes later sarcomatous. The removal of the tumour is indicated if possible, supposing it is unilateral; but the operation cannot be regarded as other than palliative, supposing the tumour to be growing rapidly at the time.

Sarcoma and carcinoma appear in patients after forty, sometimes preceded by the formation of a stone, and nephrectomy should be done whenever there is an opportunity.

A malignant tumour of the kidney forms a mass in the loin, not moving during respiration, and having the colon in front. As it grows it encroaches on the peritoneal cavity. Blood may appear early in the urine, but it is a variable sign owing to the liability of the ureter to become blocked.

When a tumour forms in a movable kidney, it cannot be distinguished from other abdominal tumours before incision, unless the tumour can be pressed back into the loin with ease.

Secondary Nephrectomy.—Nephrotomy and drainage through the loin should precede nephrectomy in cases of pyonephrosis, hydronephrosis, and tubercular disease, in order that the urine from the opposite kidney may alone enter the bladder and be collected. By this means disease, atrophy, or congenital absence of the opposite kidney may be excluded, and it can be shown before operation that one kidney is capable of doing the whole work.

Lumbar Nephrectomy.—The kidney is removed through an incision in the loin without opening the peritoneum, when the kidney is not enlarged beyond double size, and when it has been the site of suppuration and is more or less fixed by adhesions. The position of the patient and the oblique incision is the same as for nephrotomy, the incision being enlarged if necessary downwards to the crest of the ilium. The capsule is incised and stripped off from the kidney, and this may be, in inflammatory cases, a work of great difficulty. Unless the surgeon keeps within the capsule, adhesion to the portal vein or duodenum on the right side, and to the intestines on the left, may be torn through. The portal vein has been torn into, and the patient died immediately. The duodenum has been torn across, and the patient died within a week, owing to the duodenal fistula. The pelvis being reached, the ureter is separated, and a pedicle ligature tied tightly round the artery and vein. The artery must be secured before the kidney is cut away, otherwise it will retract, and cause fatal recurrent hæmorrhage. Sometimes a tumour can be divided, and each half separately ligatured. The ureter is simply tied, unless it is dilated and contains pus, when it is stitched to the edge of the wound. If the peritoneum is torn open, the contents are protected by sponges, and the rent afterwards sewn up. The nephrectomy wound is closed, except behind, where a tube or strip of gauze is inserted.

Abdominal Nephrectomy.—This operation is required for the removal of tumours in children, also for adults in whom the tumours are large or floating. It should be avoided if possible whenever suppuration has occurred.

The incision is made in the middle line, and this is enlarged by a transverse one, running horizontally outwards at the level of the umbilicus. The intestines are retracted and covered by sponges, and then the peritoneal covering of the tumour is stripped off. In doing so, the ureter is met with behind the peritoneum at the lower and inner angle of the tumour, and is clamped and divided. The tumour is now drawn forwards, and carefully separated by the hand from the structures behind until the pedicle containing the artery and vein is reached. At the upper, inner, and hinder part, great care must be taken on the right side in separating the duodenum and the portal vein, and below this the inferior cava; for although in the latter case a ligature may not be fatal, yet it exposes the patient to the complication of venous obstruction in the lower limbs. On the left side the descending colon may be closely adherent.

After ligaturing the pedicle, the tumour is cut away, including the capsule of the kidney. The cavity behind the peritoneum is drained through the loin, whilst the abdominal wound is completely sewn up.

Ureter.

Wound of the Ureter.—The ureter may be torn across or divided, and urine be extravasated. If the urine escapes behind the peritoneum, and is normal, a cyst may form; but when the urine decomposes, as it will certainly do if the kidney be already diseased, an abscess behind the peritoneum quickly forms. A more dangerous condition occurs when the urine escapes into the peritoneal cavity. This condition may be discovered by exploring the wound, or, in case there is no wound, attention is drawn to the collection of fluid in the peritoneal cavity, and the signs of commencing peritonitis. If the ends of the ureter are found, an attempt may be made to reunite them by suture, and so the kidney be saved, otherwise there is nothing to be done but nephrectomy.

The ureters may be wounded during abdominal operations, especially when removing the uterus. This injury is avoided by pushing them forwards with the bladder and peritoneum, and by ligaturing the uterine arteries close to the uterus. If divided, the ureter should be reunited by suture, or, in the case of vaginal hysterectomy, the proximal end may be inserted into the bladder.

Dilatation of the Ureter.—Owing to the compression of a pelvic tumour, one or both ureters may be dilated up to the size of a coil of intestine. When both ureters are found so dilated early in the operation, it will be better not to go on, on account of the probable atrophy of the cortex of the two kidneys. The patient is likely to die of suppression of urine, excited by the shock of the operation.

Stone in the Ureter.—A stone lodged in the ureter is felt through the abdominal wall, by exploring with the finger through a wound in the loin, by passing a probe down the ureter from the pelvis of the kidney, by palpating the lower end of the ureter through the rectum of the male and through the vagina of the female. The stone is cut down upon outside the peritoneum, removed, and the ureter sewn up. If lodged in the bladder orifice, the stone may be got at through that organ.

CHAPTER XXXIII.

SURGERY OF THE BLADDER AND URETHRA.

The Bladder and the Peritoneal Cavity.

WHILST empty, the bladder lies outside of the peritoneal cavity, and only when distended does the upper and back part of the fundus bulge into it. A rupture of this part during distension produces a communication with the peritoneal cavity. When empty, the fold of peritoneum reaches down on the front abdominal wall nearly to the pubes, and

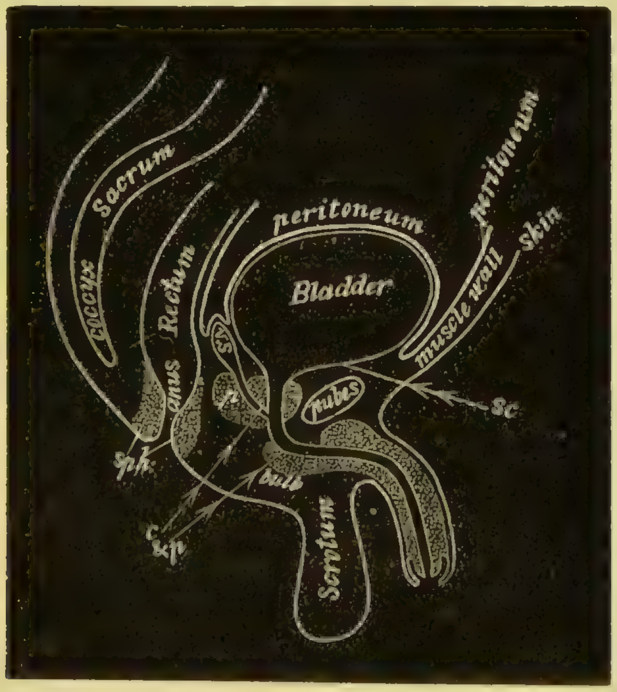

FIG. 88.—DIAGRAM OF THE BLADDER AND ADJACENT STRUCTURES.

Arrows mark the direction of: *s c*, suprapubic cystotomy; *p*, external urethrotomy; *c*, perineal cystotomy.

is raised towards the umbilicus as the bladder distends. The more the distension, the higher the fold; and this height is increased by a simultaneous distension of the rectum. The bladder, when distended, can therefore be opened through a median incision without entering the peritoneal cavity. Between the bladder and the pubes is the loose prevesical fascia and fat, a tissue easily changed into an abscess cavity by the leakage of urine. The peritoneum can be easily separated from the muscular wall of the bladder, especially in front. The peritoneum lies in contact with the bladder, in the middle line behind as far down as the prostate, and on either side it covers in the vesiculæ seminales. Commencing from below, the peritoneum can be easily pushed up, and so the bladder can be entered above the prostate, or the vesiculæ seminales removed without entering the peritoneal cavity.

The Vessels and Nerves of the Bladder.

The bladder is a vascular organ, and easily bleeds when injured or congested by inflammation. The veins are large naturally, and become more distended still from disease, and thus offer a free passage for septic agents into the circulation. The fundus of the bladder is supplied by sensory nerves from the tenth to the twelfth dorsal and the first lumbar roots, hence pain caused by retention of urine is often referred to the back of the sacrum or perineum in the area supplied by these same roots. The mucous membrane and neck of the bladder, on the other hand, is supplied by the second and third sacral nerve roots; hence the irritation of a stone in the neck of the bladder causes pain to be felt in the tip of the penis, supplied by these latter roots.

The Interior of the Bladder and the Decomposition of Urine.

The bladder can retain the urine secreted during six hours, but is overfilled by a day's urine. Regurgitation is prevented by the oblique course of the ureter through the wall, and by the circular fibres closing the projecting lip of the ureter. But experiments have shown that a retrograde or antiperistaltic wave can carry carbon particles, milk, methylene blue solution, etc., up the ureter to the pelvis. This is the way in which micro-organisms ascend when there is retention of urine.

Normal urine is not absorbed from the bladder, but poisonous materials, such as strychnine, hydrocyanic acid, cocain, are rapidly taken up, so that an animal can be killed by injecting poisons into the bladder. This experiment shows the way in which products of septic decomposition are rapidly absorbed.

Urine is retained in the bladder unaltered for six hours or more, and then there commences a slow formation of ammonium carbonate from the urea, which becomes a source of irritation and inflammation. Healthy urine, which escapes into the peritoneal cavity or into neighbouring tissues, causes at first no symptoms of its presence, but subsequently the ammoniacal fermentation sets up inflammation, which soon becomes acute, and causes gangrene.

Many forms of micro-organisms hasten the tendency of urine to undergo ammoniacal decomposition, and amongst these are the pyogenic cocci. If urine be sterilized in a sealed flask, it remains unaltered; if the contents of the flask be inoculated with a pure cultivation of a pyogenic organism, ammoniacal decomposition ensues.

The healthy bladder, however, presents such an amount of resistance as to be able to destroy pyogenic organisms which are simply injected into it. The bladder wall must be altered by artificial retention or mechanical injury before it can be affected by a pyogenic organism. In consequence, however, of retention, ammoniacal fermentation of the urine is set up, and there follows congestion, acute inflammation, and even parenchymatous hæmorrhage into the bladder wall; there is destruction of the epithelial surface, and an ulcer forms. On the other hand, small injuries do not start ammoniacal decomposition in the urine, unless pyogenic organisms are also present. The healthy bladder may be pricked, scratched, scraped, cauterized, drained by aseptic instruments, without causing the urine to become ammoniacal.

Wounds of the Bladder.

The bladder may be punctured by a bayonet thrust or by a bullet. Urine escapes from the wound, or collects in the peritoneal cavity, or infiltrates the loose connective tissue in front of the bladder. The wound in the abdominal wall is enlarged, and the hole in the bladder sewn up, and the superficial wound filled with gauze. Drainage by the perineum is set up when the posterior bladder wall outside the peritoneum is also injured.

The bladder may be wounded during abdominal operations, especially hysterectomy. The accident is avoided by preliminary emptying of the bladder, by pushing off the bladder from the tumour, and by ligaturing the uterine arteries close to the uterus. If wounded, an immediate suture is applied.

The bladder, when sacculated, is in danger of being perforated by the lithotrite when crushing a stone. When a saccule is discovered in the fundus of the bladder, lithotrity should be stopped, and the removal of the stone be completed by median perineal cystotomy. During labour the bladder may be injured by the continuous pressure of the child's head, especially when containing urine. It is either ruptured at once, or sloughing ensues, producing a vesico-vaginal fistula. The bladder may be also perforated by forceps unskilfully used. A communication between the bladder and the vagina must be closed immediately. When the edges are bruised, union fails, and the vesico-vaginal fistula has to be cured later on.

Foreign Bodies in the Bladder.

Foreign bodies ulcerate into the bladder: a sequestrum from disease of the spine or pelvis, a pessary from the vagina, needles from the intestines, silk ligatures from an ovarian pedicle.

Foreign bodies of all kinds are found in the bladder, especially of the female, having been inserted through the urethra. The end of a catheter, hairpin, ear or stem of grass, feather, pencil, pipe-stem, bootlace, paraffin, chewinggum, sealing-wax, hazel-nut, toothpick, piece of coal, are some of the objects which have been removed from the bladder.

Foreign bodies soon become encrusted with phosphates. An attempt is made to seize and withdraw the object by grasping it with a lithotrite; failing this, it must be removed by forceps, after dilating the urethra in the female, and after making a perineal wound in a man.

Rupture of the Bladder.

Intraperitoneal Rupture, uncomplicated by other injuries, commonly takes place in men who have at the time a full bladder. The violence necessary to cause rupture is often comparatively slight, such as the fall of a drunken man on his stomach. An intraperitoneal rupture has been caused in a woman by a kick on the hypogastrium. Severe violence may produce both an intraperitoneal and an extraperitoneal rupture. The part of the bladder generally ruptured is the highest portion of the fundus. The signs of intraperitoneal rupture are inability to pass water, and loss of desire to empty a bladder known to have been full before the accident. No pain may be felt until peritonitis sets in, and this may be delayed for upwards of two days, if the urine be perfectly healthy; but peritonitis follows directly upon the accident when the urine is already alkaline. On examination, no tumour is felt in the hypogastrium, but there is free fluid in the peritoneal cavity. The pelvis and perineum are normal in an uncomplicated case, and a catheter passes easily into the bladder, but only draws off a few drops of blood-stained urine. On moving a silver catheter about, the end may slip through the rent, and be felt immediately behind the abdominal wall. Then urine escapes freely, the stream increasing in force with the descent of the diaphragm during inspiration. If air be pumped in through the urethra, it enters the abdominal cavity, and does not inflate the bladder. The abdomen must be opened forthwith, the rent sewn up and made watertight, as proved by injecting permanganate or aniline blue solution into the bladder. The peritoneal cavity is thoroughly washed. Drainage is only required when septic peritonitis has already set in. A catheter is not tied into the urethra unless the case is complicated by an extraperitoneal rupture or by a urethral stricture (see p. 92).

Extraperitoneal Rupture occurs from severe violence, and is generally owing to fracture of the pelvis. The rupture takes place about the neck of the bladder, and extends more or less into the trigone.

In addition to the signs of a fractured pelvis, a fluctuating swelling is found in the perineum and about the prostate, and this is connected with another swelling above and behind the pubes.

A catheter passes freely down the urethra, but may be arrested at the neck of the bladder. A careful examination is made in order to exclude intraperitoneal rupture, and also to find out if urine is being extravasated.

In slight or doubtful cases of injury to the neck of the bladder the urine is drawn off every four hours, and the bladder washed out, or a catheter may be tied in and be changed after a day. But when a catheter cannot be passed, and a swelling is felt in the perineum, an incision is at once made, and the finger passed into the bladder, followed by a rubber tube without side-holes. If the ends of the fractured pubes are felt, and the extravasation of blood and urine extends upwards towards the hypogastrium, an opening must be made above the pubes, and a tube carried right through to the perineum. Through this drain irrigation is done at frequent intervals.

Rupture of the Urethra is caused by a fall on the perineum, or is a complication of fracture of the pelvis. Blood escapes from the urethra unconnected with micturition, and if the patient has the power of passing water, blood-clot escapes first of all, after which the urine is clear. When the patient can pass his water, and on examination of the perineum there is no sign of extravasation, nothing is done for a few days; then a bougie is passed, and dilatation is continued for a long time, until all tendency to stricture has passed away. When a patient cannot voluntarily pass water, but, on the other hand, a catheter easily passes, the urine is drawn off at intervals, or a catheter is tied in for a day or two, until the power of micturition is regained.

When a patient is unable to pass water, and a catheter cannot be passed, also at the first sign of any perineal extravasation, an incision is made, and the two ends of the urethra united by suture, until it is water-tight; the superficial wound is then filled with gauze.

When extravasation and gangrene of the tissues have already become established, or when there is a fracture of the pelvis, it will be useless to attempt the union of the urethra.

Rupture when neglected produces a traumatic stricture, and a long course of dilatation has to be undergone.

If the stricture is very hard, and not amenable to dilatation, it may be excised, and the two ends of the urethra united; or it may be divided longitudinally by external urethrotomy. A traumatic stricture which is neglected has the same backward effect on the bladder and kidneys as one due to gonorrhœa.

Examination of the Bladder.

Palpation and Percussion.—The bladder is to be felt when partly distended by one hand on the hypogastrium, and the other in the rectum of the male or in the vagina. It is then possible to feel stones, except very small ones, also malignant disease can be detected when it has involved the bladder-wall. The finger in the rectum detects enlargements of the lateral lobes of the prostate, and also a markedly enlarged middle lobe can be made out. Changes in the vesiculæ seminales, and a cyst or abscess in the recto-vesical tissue, are to be felt.

Catheterism and Sounding.—Catheters are rendered aseptic by wiping and syringing them with 5 per cent. carbolic acid immediately after use. If a catheter is to be used several times a day, it is better to keep it steeped in the solution. Silver catheters can be boiled in soda solution. Sounds and bougies are easily cleaned, as long as they have a polished and smooth surface.

Catheterism is required (1) *for retention of urine.* Retention of urine in a boy is due to impaction of a calculus or foreign body in the urethra. In a girl retention is assumed to be of neurotic origin ; hot fomentations are applied to the hypogastrium, or the patient is seated in a hot bath ; a purge is given and a hot-water enema. A catheter is not to be passed, nor an examination made until a full trial of the other measures. In a married woman retention is due to the impaction of the retroverted gravid uterus in the pelvis ; less often it is occasioned by a fibroid similarly impacted. The retention is relieved by catheter, and by pushing up the tumour in the genupectoral position. In man retention is generally due to stricture or enlargement of the prostate. It occurs in the first stage of gonorrhœa, from swelling and spasm of the urethra. Catheterism should not be employed at first, in order to avoid the danger of pushing back the gonorrhœal organisms into the bladder. Retention is common after operations, especially after the removal of piles. Two other causes of retention, impaction of a foreign body or of a calculus, and also from neurosis, are likewise met with in men. (2) *For removal of foul and purulent urine, and for washing out the bladder.* (3) *For diagnosis.* Urine is obtained uncontaminated by urethral and vaginal discharges.

Catheterism.—A full-size gum-elastic or rubber catheter is first tried. It is well greased with vaseline or with glycerine containing 1 in 1,000 perchloride of mercury. The patient should always lie down. If the patient is over fifty, an obstruction may be met with at the prostate. Then an elbowed catheter will often pass. By using full-sized instruments first of all hæmorrhage is avoided, as the urethral mucous membrane about an enlarged prostate is always in a state of venous congestion. There is no narrowing of the lumen in the case of enlarged prostate, and a full-sized instrument is more likely to get round the sharp curve.

When an obstruction is met with in front of the prostate, smaller sizes are tried—even a fine whalebone bougie or a stiffish piece of catgut. If nothing passes, and the case is not urgent, the patient is put to bed and purged, kept on a low diet, or given opium, and catheterism is tried again.

Metal instruments are required in order that the opening of false passages may be avoided, and the sharp curve of the urethra may be passed. The shape nearly approaches the curve of the urethra, as shown in frozen sagittal sections of the bladder and penis. The beak is kept against the floor of the penile urethra to avoid pockets, then against the roof of the membranous and prostatic portion to avoid false passages from the bulbous portion leading backwards towards the rectum. A finger is inserted into the rectum, which aids in lifting the instrument forwards when once the beak has engaged beneath the pubes, and any accidental wounding of the rectum is avoided.

Sounding.—Sounds are made with a sharply-curved blunt beak, and cannot therefore be passed until a stricture has been dilated ; but they will pass over an enlarged prostate. Sounding can be done without an anæsthetic, but if the result is negative, the absence of a calculus is not thereby assured, especially where there is an enlarged prostate and pouches. It is in such cases, after a careful sounding under an anæsthetic, that the existence of a stone in the bladder is disproved. For sounding, the patient lies with his hips well raised, and the bladder is examined when partly distended, and then when nearly empty. In a child the sound nearly always strikes the stone as it enters the bladder. In an adult the sound is pushed to the full extent of the fundus ; then the beak explores the front and sides of the bladder systematically, and is then turned so as to explore a post-prostatic pouch ; and this last manœuvre is facilitated by a finger in the rectum pressing forwards so as to bring a stone within touch of the sound.

A stone, when touched, is felt through the sound, and if struck sharply the bystanders can hear it, or it is easily perceived through a stethoscope on the hypogastrium. A stone yields a ringing note as compared with calcareous deposits ; it can be felt by moving the beak round it, or can be seized and measured by a lithotrite.

After being catheterized or sounded for the first time, a patient should go to bed, and get into a sweat by covering himself with blankets, and sipping hot water. Hot bottles may be put into the bed, and some hot brandy-and-water or opium taken; or the patient may have a hot bath. These measures may prevent a rigor, or its recurrence. If the rigors should recur, full doses of quinine are administered. If aseptic instruments are used, and there is no escape of pus or urine into the tissues, rigors need not be feared. When there is septic absorption fatal nephritis and suppression of urine may be set up. External urethrotomy, by which the bladder is entered, is not followed by severe rigors, and therefore should be adopted in all doubtful cases where rigors have followed septic absorption, or when it is feared that the kidneys are already diseased.

The Cystoscope and Urethroscope.

The cystoscope is employed for exploring the wall of the bladder and the orifices of the ureters in doubtful cases. The bladder has to be well washed out, and filled with 5 to 6 ozs. of clear water. A cystoscopic examination may detect a villous growth, an ulcer, or renal hæmaturia. It cannot be used until a stricture of the urethra has been cured; it is unsuitable for use in cases of enlarged prostate, and of sacculated or contracted bladder. If there is much blood or pus, it is difficult to keep the water clear. General anæsthesia is usually required. Anæsthesia with cocain in some cases suffices, but this may not be so, for not more than ½ grain in a 2 per cent. solution should ever be injected into the urethra at a sitting. Many accidents—even fatal ones—have happened from over-doses.

The lamp must not be illuminated until well in the bladder, and must not then touch the bladder wall. The light must be turned off, and time allowed for the lamp to cool before withdrawing it. Only a very small field is taken in the mirror, hence the liability of overlooking diseased conditions, and, secondly, of mistaking prominences and rugæ of the normal mucous membrane for disease. Cystoscopy per urethram has therefore only a limited use. The only complete way of illuminating the bladder is by a glow-lamp inserted through a suprapubic wound.

The urethroscope is a long speculum illuminated by an external lamp. A large size has to be employed, which is therefore painful when the urethra is at all inflamed; it is apt to cause bleeding by producing fissures, which become ulcers. Thus the instrument is apt to set up the very conditions for which it is passed. The liability to cause pain and hæmorrhage is intensified when the urethroscope is pushed on into the prostatic portion. A better view is obtained by filling the urethra with air.

Purulent Urethritis—Gonorrhœa.

Purulent urethritis is practically always a venereal disease. The organisms known as gonococci are one of the causes, but many other kinds are present, and gonococci can often not be found, especially in chronic cases, which are undoubtedly capable of transmitting gonorrhœa. There are also differences in susceptibility, in that an attack of gonorrhœa may begin as an acute muco-purulent inflammation with a profuse discharge; or there may be only a slight discharge without inflammation; and in a third series there are no signs of the infection noted by the patient; and yet the later supervention of undoubted sequelæ necessitates the conclusion that the disease must have been then inoculated. There are also abundant instances of mixed infection, in which, along with gonorrhœa, syphilis is acquired, although there is no sign then or afterwards of the specific primary lesions. More frequently still soft sores also occur. The most rare is a concomitant septic infection extending to the bladder, kidneys, the peritoneum of the female through the uterus and fallopian tubes; or a pyæmic infection is generalized by the circulation, and attacks the endocardium, arteries, joints, etc. An acute swelling and profuse discharge of muco-pus may involve chiefly the prepuce (posthitis), the glans (balanitis), the anterior part of the urethra, or extend back as far as the membranous portion.

The commonest complication is chordee, the next acute epididymitis, during which the urethral discharge is very much less; but it increases again when the epididymitis subsides. Prostatitis is much rarer; so also is an abscess in Cowper's gland.

The penis should be washed frequently, especially after each micturition, and enclosed loosely in a bag, in the bottom of which is some antiseptic wool. The patient should drink as much water or other bland fluid as he can, and pass water at least every four hours. A purge is given to relieve pelvic congestion. Non-irritating diuretics are useful by increasing the amount of urine. Drugs are also used in order to add an antiseptic to the urine, such as salicylate of soda ; or oleo-resins, such as cubebs, which can be taken as a powder stirred up in cold water, or copaiba or peru balsam and sandalwood-oil, which can be suspended in mixtures or given in capsules. Copaiba often causes a rash.

The one thing that should not be done is the passage of any instrument, medicated bougie, or injection in the early stages of gonorrhœa, so that, if possible, the disease may be confined to the anterior urethra. The urethra is far better washed out from behind forwards during normal micturition, and the danger of setting up posterior urethritis is avoided. The attempt to cut short gonorrhœa by caustic or strong astringent solutions causes a great increase in the discharge as an immediate result, and the tendency to chronic gleet and stricture is in no way lessened.

Chronic gleet is treated chiefly by keeping up dilatation of the urethra, and may be cured if alcohol and reinfection are avoided. Direct applications to the mucous membrane of caustics and astringent solutions are not of much service. Medicated bougies of iodoform or of nitrate of silver are more useful.

Dilatation of the Urethra.

Dilatation is required to stop a chronic gleet, to prevent the formation of a stricture, and to relieve gonorrhœal rheumatism. It should be done without rupturing or cutting the urethral mucous membrane. When passed for chronic gleet, a gum-elastic bougie, inserted with gentleness, meets with resistance commonly at the junction of the membranous and bulbous urethra, and then a cutting pain is felt in the perineum.

Dilatation is proceeded with from day to day, until No. 12 (English) is reached, avoiding the causation of pain and bleeding. In addition, tonics, change of air, and abstention from alcohol are necessary. It takes one, two, or several years for the urethra to return to its normal state. In the meantime coitus, even after marriage, will re-awaken the disease sufficiently to infect the wife, although scarcely noticed by the husband. A number of the ailments from which women suffer after marriage are due to gonorrhœa lying latent in the urethra of the husband. Then muco-purulent inflammations complicate childbed and induce sterility.

Gonorrhœal rheumatism is the result of the absorption of products from the urethra at a point where a stricture, partly spasmodic, partly organic, is present. The dilatation of the urethra without injuring it is the special way of affording relief. Unfortunately, gonorrhœa, as the cause of the rheumatism, is often overlooked, as the patient does not complain of any urethral discharge, or ignores the slight gleet really present, and the stricture is not sufficient to obstruct micturition. When a young man suffers from chronic pain in the joints and ligaments, which commenced in an indefinite fashion, a possible gonorrhœal origin should be considered. Such pain should not be ascribed to ordinary rheumatism, unless there is a clear history of an acute attack of rheumatic fever, or of exposure to severe cold and wet. Gonorrhœal rheumatism attacks especially the ligaments about joints, including the plantar ligaments. Fluid collects in the joints. If the disease persists, the capsule thickens, and adhesions take place. Gonorrhœal rheumatism is much improved by dilating the urethra, also internal remedies are given, such as guaiacum, sulphur, or iodide of potassium; sulphur, or mercury ointment is applied, or sulphur baths are used. In severe cases, especially in tubercular subjects, suppuration may supervene. (See further under Joints.)

Tight Organic Strictures.

The sign of an organic stricture is difficult micturition, with pain in the perineum; the act is more and more prolonged, the stream smaller and irregular, or forked, when the stricture is in the penile urethra or at the meatus.

Micturition may be increased in frequency, owing to irritation of the dilated prostatic urethra or of the bladder. Retention ensues, owing to swelling of the mucous membrane in addition to the stricture, caused, *e.g.*, by an extra quantity of alcohol being taken. A stricture which has not been previously subjected to instrumental treatment is generally permeable to a small gum-elastic bougie, especially if the patient has been purged and kept in bed for a day or two on a low diet. When a false passage has been previously made, it may be looked for at the lowest part of the urethra, passing backwards towards the rectum. A steel bougie sharply curved like the hinder part of the urethra, as seen in a frozen section, can be most easily guided past the opening of the false passage by keeping the beak against the roof of the urethra, and the finger of the left hand in the rectum assists in guiding the beak.

Dilatation up to the full size may be done rapidly under an anæsthetic, or when no anæsthetic is employed, gradually, so as to complete the dilatation in several sittings according to the tolerance of the patient.

Internal Urethrotomy.

Strictures of the meatus and penile urethra are resilient, and quickly retract after dilatation, unless first divided by a knife. A straight blunt-pointed bistoury is used near the meatus. Further back a special form of urethrotome, in which the knife is protruded at will, is employed. The cutting should be done upwards, lest an abscess and penile fistula form. After the cutting, the urethra is dilated to No. 16 (English). Dilatation is kept up by the passage of a bougie at increasing intervals, at first weekly, then monthly, finally yearly, until all tendency to retraction has disappeared.

Retention of a Catheter.

A catheter is only retained when its passage is a very difficult matter, and then only for a day or two, as it is apt to be painful and irritate the bladder. A catheter, either a gum-elastic or silver one, is tied in by tapes from the handle, a tape is brought back on each side of the penis and fixed to the penis and pubes by strapping. The pubic hairs should be first shaved off, or they become entangled in the tapes or adherent to the strapping. The retained catheter should be washed through twice a day, and its orifice kept closed by a peg. Phosphates will begin to encrust it after a day or so, according to the alkalinity of the urine. When the retention of the catheter for a few days does not make the urethra a free passage, the method should be discarded, and perineal drainage of the bladder set up instead.

Removal of Foreign Bodies from the Urethra.

A foreign body which has been pushed into the urethra can often by pressure from behind be pushed out again, or it may be seized and extracted by long, thin-bladed forceps. A great difficulty occurs with ears of corn or grass pushed in stem first, for they always stick and prevent extraction. Pins of various kinds have been also pushed down head first, such as women's hair- or hat-pins. After a trial with forceps, a urethral speculum is passed down; and if the foreign body can be got into the speculum, both are withdrawn together. A hat-pin may be pushed on until the point protrudes through the urethra and the skin; then, by drawing on the pin until only the head is still in the urethra, the direction of the head is reversed, and it is pushed towards the meatus, where the head can be seized and the whole pin withdrawn. If the foreign body cannot be extracted through the meatus, it must be removed by an incision in the perineum.

Perineal Urethrotomy—Median Perineal Cystotomy.

A median incision into the urethra is made in order to suture the urethra after injury, in order to treat an impermeable stricture, to remove a foreign body, in order to explore digitally the bladder, aided by counter-pressure on the hypogastrium. Through this incision pedunculated tumours may be removed from the bladder, a foreign body which cannot be crushed, or fragments of stone may be extracted, a lithotrite may be inserted through the perineal wound in order to break up a stone, which cannot otherwise be removed, and finally the incision may be employed for draining the bladder.

The patient is held in the lithotomy position, and a grooved staff passed as a guide, which an assistant holds firmly, with its shank vertical. An incision $1\frac{1}{2}$ inches long is made over the central point of the perineum, or midway between the fold of the scrotum and the margin of the anus. The incision is carried down to the groove of the staff, guided by the touch of the left index-finger. Into the groove the probe-pointed end of a gorget is passed and pushed along to the bladder. The usual incision is a median one, but very little room is given, the cutting cannot be guided by the eye, nor the bloodvessels ligatured. It simplifies matters if the incision is made transversely, or, rather, a curved incision crossing the middle point of the perineum, the two ends extending backward on each side of the anus (see p. 425), and then all the bleeding-points can be tied.

External Urethrotomy for Impermeable Stricture.

An impermeable stricture is treated by the following operations. When the stricture is confined to the membranous and commencement of the bulbous urethra, Wheelhouse's operation is indicated. A straight staff is passed down to the anterior face of the stricture, and its end is cut down upon through the perineum. The sides of the urethra being held aside, a probe is passed, guided by the eye with more or less difficulty, through the stricture; the probe is followed by a director, and the director by a probe-pointed gorget. A full-sized catheter may be tied in and changed every day, or a steel bougie can be passed daily, the beak being kept against the upper wall, so as not to engage in the wound.

When the strictures are multiple, involving the penile urethra, a Wheelhouse's operation would require too long an incision into the urethra. Cock's operation is indicated for such a case. The patient is held firmly and exactly straight, so that the nose, umbilicus, and penis are in line. The surgeon inserts his left forefinger into the rectum, and places it on the anterior end of the prostate, so as to feel the under surface of the triangular ligament; he then takes a straight blunt-backed knife and plunges it in, with the edge upwards, from the middle point of the perineum, so that it shall pass immediately under the bony arch of the pubes in the middle line. Urine escapes beside the knife when it enters the bladder. This operation is rendered easier by the fact that the prostatic urethra is dilated behind the stricture. The knife is withdrawn, and a probe-pointed gorget or the finger inserted. The urethral stricture can be immediately and fully dilated, or a tube may be inserted into the bladder, which then drains through the perineum for a week. Meanwhile, the urethra being at rest, spasm is diminished, so that the strictures tend partly to diminish, and dilatation can be easily carried out without further anæsthetic. This 'buttonhole' incision in the perineum quickly heals.

Extravasation of Urine.

The worst cases are in men subsequent to stricture. Slight cases are seen in boys after impaction of a calculus, tight phimosis, or the constriction of the penis by a band. Extravasation is preceded by dilatation of the urethra behind the stricture, with or without the formation of an abscess. If an abscess first forms, pain in the perineum is followed by a brawny swelling. Suddenly, after a slight strain, a giving way is felt, the swelling becomes more diffused, and the dusky-red hue changes to a blacker colour, and quickly becomes gangrenous. The bladder, which was distended, is now less tense, and the desire for micturition also less; on straining, only a little blood passes; a rapid œdema of the penis and scrotum follows, and a general urinous odour is perceptible. Further extension takes place to the abdominal wall on either side and above the root of the penis. Meanwhile, the patient's senses are rendered dull, so that, as there is no longer a desire to pass water, and, in the absence of acute pain, the case may be neglected for a time, later on he loses consciousness, and dies of general septicæmia, the end occurring with the greater rapidity the more diseased the kidneys.

Immediately on the formation of a urethral abscess, or on the mere suspicion of extravasation, the perineum is explored, and if the subcutaneous tissues are infiltrated with a urinous œdema or gaseous pus, or are gangrenous, a free opening is made into the bladder and a drain inserted. This free drainage of the bladder is the most essential point of the treatment; the finger should always enter the bladder to ensure its having been reached. If this is not done, infiltration continues until death. Besides this drainage of the bladder, free incisions are made into the œdematous subcutaneous tissue, and along the sides of the penis; when the scrotum is infiltrated, the incision must extend into the tunica vaginalis testis, where the fluid tends to collect. Smaller incisions are made on the abdominal wall wherever there is any œdema or redness. Iodoform powder is dusted on the wounds and absorbent dry dressing applied. Any sloughs are cut away as early as possible. The prognosis is dependent on the state of the kidneys. Recovery may take place even after very extensive infiltration, supposing the kidneys are fairly healthy; when diseased, the patient quickly sinks, in spite of the free drainage. In a few days the patient may be able to sit in a bath containing permanganate, which will hasten the separation of the sloughs and the healing.

Urethral Abscess and Fistula.

A urethral abscess is commonly the result of a stricture, but may also be caused by the impaction of a calculus or foreign body, or arise in Cowper's gland. If the abscess is opened and the cause removed, healing will probably take place at once. When the abscess bursts, a fistula may result, especially if there is a stricture. A single urethral fistula may be perineal, scrotal, or penile, according to the position of the external orifice. If multiple, some one or more fistulæ may open at some distance from the urethra to one side of the anus, in the groin, or on the inner surface of the thigh.

Perineal and scrotal fistulæ are generally cured without difficulty by dilating the urethra to the full extent, and keeping it dilated whilst the fistula is scraped and filled with gauze, so as to bring about healing from the bottom.

Multiple fistulæ are treated by ensuring full perineal drainage, so as to cut off the urine from the other fistulæ, which are scraped, irrigated, and dressed with gauze until they are all healed. Then the remaining perineal fistula is allowed to close, which it does if the urethra is fully dilated.

The most troublesome fistula to cure is the penile. Sometimes this is best treated by perineal drainage, sometimes by a plastic operation; the more difficult ones require a combination of both methods. A plastic operation for the cure of a penile fistula consists in raising a flap of skin on one side of the fistula, then the margin of the fistula is excised, and the mucous membrane lining it invaginated towards the urethra, and the raw surfaces sutured (Fig. 89). After this the flap of skin is brought over in such a way that the line of union of the flap is not opposite to the position of the invaginated fistula.

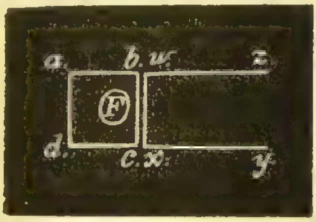

Fig. 89.—Penile Fistula.

F, Orifice of fistula; *a*, *b*, *c*, *d*, skin excised around fistula; *z*, *w*, *x*, *y*, flap raised and drawn forwards, so that the edge, *w x*, can be sutured to margin, *a d*.

Incontinence of Urine.

In the infant, micturition is a reflex act, and continues so until the brain gains power over the sphincter, which then relaxes only in obedience to the will. This power of the brain over the sphincter is gained at different ages in children, and earlier in the case of boys than girls. It is disturbed by mental excitement, or overcome by other reflex impulses, such as those arising from disturbances of digestion or from worms, especially during sleep. Judicious and kind education aids the gaining of control, scolding or punishing the child delays it. Nocturnal incontinence is improved by diminishing the amount of fluid taken towards bedtime, substituting milk-and-water for tea, and causing the child to pass water in the middle of the night to prevent the distended bladder relaxing the sphincter. Belladonna acts as a slight anæsthetic, and so diminishes the tendency for the starting of this reflex effect. The tincture may be exhibited in doses beginning from 2 minims three times a day, up to 10 or even 15 minims. It is well borne, and the paralysis of accommodation and of the iris does not matter in a young child.

Incontinence by day as well as by night may be due to some abnormality of the urethra in girls. The urethra may be patent, or the mucous membrane prolapsed, or a persistent Wolffian duct may lead from the kidney and open into the urethra in front of the sphincter.

Persistent incontinence of urine in young women is to be first treated by tonics, aperients, and by belladonna. This failing, a full examination becomes necessary, when some disease or abnormality may be found. In case not, the urethra is slightly cauterized, so as to produce some partial narrowing. Failing this, the urethra has been dissected up, twisted upon itself through 180°, and then fixed in that position.

Incontinence attends a deficiency of intellect in either sex; it accompanies spina bifida, including the masked form, where only a hairy mole, and not a tumour, covers in the site.

Incontinence of urine follows on an injury to the spinal cord, from which partial or complete recovery may ensue. When consequent upon degenerative affections of the central nervous system, no improvement can be hoped for.

In incurable cases, a suitable clamp is worn on the penis (jugum penis). In other cases a urinal is attached to the thigh.

Cystitis.

Cystitis is generally of the chronic or subacute form, and only exceptionally acute. Occasionally gonorrhœa both in the male and female causes an acute attack; so also may the bursting of an abscess, the introduction of a foreign body or a septic catheter. In women, acute cystitis and exfoliation of the mucous membrane may follow on a prolonged labour. Subacute and chronic cystitis is often due to retention of urine from stricture or enlarged prostate. It may be owing to the presence of a stone, foreign body, or tumour, or ulcer in the bladder. It is caused by infection from without, gonorrhœa, or the introduction of a septic catheter; or the bladder may be infected from the kidney.

The symptoms of cystitis are frequent micturition, with pain over the bladder. The treatment consists, after making a diagnosis, in removing the cause. In addition, the bladder is frequently irrigated with hot water, commencing at 95° F., and increasing the temperature up to 120° F. Antiseptic substances may be added, but the solutions should be weak, *e.g.*, permanganate of potash, 1 per cent.; boric acid, 3 per cent.; carbolic acid, 0·5 per cent.; quinine sulphate, 1 in 500; silver nitrate, 1 in 500; perchloride of mercury, 1 in 10,000. The internal remedies are the tolu, peru and copaiva balsams, sandalwood or turpentine oil; infusion of buchu, cubebs, salol, salicylates or benzoates, the alkaline carbonates or boric acid. Against pain, belladonna, hyoscyamus, opium, or morphine, are given internally or used as rectal suppositories. Poultices, turpentine fomentations, or leeches may be applied to the perineum or hypogastrium. Whenever there is any difficulty in the passage of the urine through the urethra, drainage is required.

Tubercular Ulceration of the Bladder.

Tubercular disease of the bladder is one of the rarer forms of local tuberculosis; when once established it is extremely painful, and rarely curable. The disease is indicated by pain over the bladder and frequent micturition in a young strumous subject, the urine is alkaline, and tubercle bacilli are easily found, or may be demonstrated by inoculation experiments.

Tuberculous cystitis is first treated by cod-liver oil and iron, and also by daily injections of lactic acid, beginning from 1 per cent. and gradually increasing in strength, or of iodoform emulsion. Failing any improvement, erasion of the mucous membrane is done through the perineum, and so the whole of the mucous membrane may be removed. Or a suprapubic incision is made, the interior of the bladder explored, and the separate ulcers cauterized or rubbed with strong lactic acid. The perineal operation is best where the whole mucous membrane is involved, as it avoids a suprapubic fistula, and may be repeated without the danger of opening the peritoneum. The suprapubic operation is the more exact for separate ulcers. After the operation, the treatment is continued as before, and the erasion may have to be repeated several times. Relief follows even in advanced cases, but cure can scarcely be hoped for when the disease has extended beyond the mucous membrane. In hopeless cases opium and morphine are freely used to relieve pain, as suppositories, as injections, by the mouth or hypodermically.

Stone in the Bladder—Bladder Calculus.

From some unknown cause, stone in the bladder is common in certain districts, *e.g.*, the country round Norwich, part of the north-west provinces of India, and in the government of Moscow. In many places calculus is among the rarest of diseases. Neither the climate, nor soil, nor water of the districts affords an explanation.

It has been conjectured that micro-organisms may cause stone. This is certainly the case in Egypt, where the frequency is due to bilharzia ova. Diet is also thought to have some influence on the formation of stone.

Stone is most frequently seen in England (apart from Norfolk) in well-to-do men past middle life, often accompanied by some enlargement of the prostate. It is impossible to ascribe such cases to an excess of meat diet, for the people mostly affected by stone in India are vegetarians, and the horse and the ox are subject to stone. Uric acid calculus was formerly frequent among the children of the poor, and was attributed to errors of diet; but such cases have remarkably diminished of late years.

The nucleus of a calculus may first form in the kidney, but stone in the kidney does not seem to be specially common in the districts where it is common in the bladder.

A cystin calculus occurs with cystinuria, and an oxalate calculus with oxaluria, the corresponding crystals being found in the urine; but, although some peculiar metabolism is at work, there is no connection with diet.

The symptoms which suggest the presence of a stone in the bladder are frequent micturition, with pain at the end of the penis, and intermittent hæmorrhage. The symptoms are made worse by movement or jolting, and are relieved by rest at night. When the urine is alkaline and contains pus, the case is recognised as being of some standing. Anæmia, albuminuria, and a furred dry tongue show that the kidneys are already seriously damaged.

A stone is proved to be present in the bladder when it can be struck repeatedly with the sound. The surgeon feels the sound touch the stone, and the sound is audible either to the bystanders or to anyone who listens with a stethoscope placed on the hypogastrium. The rugæ of the bladder—especially when covered with phosphates—yield a low grating sound, but not the sharp ringing sound caused by striking a stone. The sound made on striking a foreign body will vary according to its nature, and according to the amount of phosphates encrusting it.

Stone may be overlooked in old men with an enlarged prostate or sacculated bladder. In the case of an enlarged prostate, the sound must be introduced far enough to reach the bladder. Its beak is turned downwards, whilst the prostatic pouch is pushed upwards. Numerous cases have occurred of stones being at first overlooked in old men with enlarged prostate, but which were easily found when the patient was fully anæsthetized. A small stone may be made to click against a cannula when fluid is sucked out by means of an evacuating syringe.

A stone having been found in the bladder, its removal is invariably indicated, and this is always most successful when it follows directly upon the sounding. Even in a diabetic, a stone has been successfully removed by lithotrity.

A calculus may be passed by the urethra, or lodge in it, or get into a perineal or other abscess, and be discharged through a fistulous opening. A calculus may ulcerate from a prostatic pouch into the rectum, or cause sacculation and protrusion of the mucous membrane of the bladder between the muscular fibres, so as to bring the pouch into contact with the peritoneum, and then perforation into the peritoneal cavity is liable to occur at any time. A stone may form in a patent urachus, or in the pouch of bladder contained in an inguinal hernia. Death is caused by exhaustion from pain and frequent micturition, from septic extension to the kidneys, causing interstitial nephritis and multiple abscesses, pyonephrosis, and, in the end, suppression of urine.

Lithotrity per Urethram is now the operation for stone in the bladder. Lithotrity requires a healthy bladder free from sacculation; it is therefore specially indicated for children. Alkalinity of the urine, with much pus and triple phosphate crystals, contra-indicate lithotrity. Stricture of the urethra may offer merely a mechanical bar to the passage of the lithotrite, or, by setting up changes in the bladder and kidneys, contra-indicate it. Lithotrity may be done in the case of enlarged prostate, if the urine is fairly healthy, and the stone in a pouch behind the prostate.

The bladder should contain about 6 ounces of clean water; the patient's pelvis should be raised; the lithotrite used should be as large as possible. The meatus may require a nick. The stone is first examined with a sound, next touched with the lithotrite; the jaws are opened, the female blade depressed, and a slight shake given, then the jaws are closed without moving the female blade. The stone may be caught, and, on screwing up, felt to be crushed; or it may slip out, or not be caught at all. After grasping the stone, but before commencing to crush, the lithotrite should be rotated, so as to avoid injuring mucous membrane. The chief art of lithotrity is to seek the stone at the spot where the stone has lain, and there also the fragments must be crushed. The washing out of the fragments may be done with a simple cannula and syringe, or an evacuator, *i.e.*, a special form of aspirating syringe, may be employed. The crushing and evacuation are repeated until not a fragment can be detected by the sound.

The chief complication of lithotrity is due to sacculation; the wall of a sacculus may be so damaged that perforation and fatal peritonitis ensue. This is prevented by avoiding lithotrity where sacculation is likely to be present, or by changing to a median perineal lithotomy, and completely removing the fragments, followed by drainage, when the presence of a sacculus is detected during the course of the lithotrity. This is especially indicated when the stone is always touched at one spot, but cannot be fairly seized. Recurrence takes place after lithotrity from small fragments left behind, and also from a continuance of the causes producing stone.

Lithotrity in Children.—A stone has been successfully crushed in a baby of fifteen months with a No. 5 lithotrite. Nos. 7 and 8 are common sizes for boys.

Lithotrity is easy in women.

A stone may be of such a size that a lithotrite passed by the urethra cannot grasp it. Larger lithotrites than will pass through the urethra may be used through a median perineal cystotomy wound. Suprapubic cystotomy is required for the largest sizes of hard stones.

Suprapubic Operations on the Bladder.

Puncture of the Distended Bladder above the Pubes.—This operation seems at first sight an easy plan of withdrawing the urine when a catheter cannot be passed through the urethra; but it should be very rarely used. Septic abscesses and extravasation of urine into the loose connective tissue in front of the bladder are likely to occur; for although the trocar is aseptic when entering the bladder, it is not so as it is withdrawn; neither does the wall of a diseased bladder close over the puncture like a healthy one, for it is composed of rigid inflammatory tissue instead of muscular fibres. Moreover, the effect of the withdrawal of the urine is but temporary; the bladder soon refills, and is then the more likely to leak. Therefore, in all the common cases of retention from stricture, some perineal operation should be done forthwith. Aspiration may be done once in the case of sudden retention due to overfilling in a man with enlarged prostate, for then there is a good prospect of the urine being passed freely after the bladder has been once emptied.

A fine aspirating trocar and cannula should be inserted in the middle line immediately above the pubes, and plunged downwards towards the junction of the sacrum and coccyx.

When suprapubic drainage is required, the bladder is generally explored first through an incision. If it be wished, however, to set up drainage in a very weakly patient without an anæsthetic, the bladder may be tapped with a large ascites trocar and cannula. The trocar is withdrawn, and through the cannula is passed a rubber catheter, which is fixed by strapping after the cannula has been withdrawn over it. The end of the catheter is then put into a urine-bottle between the legs, or joined to a rubber tube, which conducts the urine into a vessel under the bed.

Suprapubic Cystotomy. — Suprapubic cystotomy is primarily an exploratory operation, in the course of which the interior of the bladder can be fully examined, further procedures being determined by the conditions found.

The bladder is first distended enough to be felt above the pubes. The bladder may be full of urine, or the urine can be drawn off and 6 ounces of water injected, or the organ may be distended with air by a ball syringe. If not sufficiently prominent, a bag is inserted into the rectum and distended to about 6 ounces, or a sponge may be pushed in, or the bladder can be pushed forward by the assistant's finger in the rectum. The incision is made in the middle line for about 3 inches, and its lower end overlaps the pubes. The wound may be enlarged by dividing the abdominal wall outside the peritoneum either upwards towards the umbilicus or transversely just above the pubes. The recti are separated by retractors; if more room is required, their insertion into the pubes is cut away. The fat in front of the bladder is separated by two pairs of anatomy forceps, and if the fold of peritoneum is seen, it is carefully pushed up. The bladder wall being recognised, it is fixed on either side by a suture or by clamp forceps, so that it cannot fall back when the water flows out. When the bladder is a small and contracted one, it cannot be sufficiently distended without danger of rupturing; it has then to be sought for down behind the pubes, and is drawn up by a couple of clamp forceps. The bladder is cut into between the two fixed points, and the finger thrust into the incision before the water flows out. The bladder is first explored by the finger, then by a sound; the wound may be enlarged, and the interior illuminated by a small electric lamp. A vaginal speculum may be passed until it comes in contact with the wall, then the interior of the speculum is dried out and illuminated, and in this way any special spot on the mucous membrane can be minutely examined. Stones are removed with the fingers, forceps, scoop, or after crushing. A stone fixed in a pouch has been split up by blows with a mallet and chisel.

A simple tumour may be pinched off with forceps, or cut away with scissors. An enlarged lobe of the prostate may be cut off with scissors, plucked away, or shelled out with the finger. Part of the anterior wall of the bladder has been excised for malignant disease after peeling off the peritoneum.

Ulcers of the bladder are scraped, cauterized, and lactic acid, iodoform, etc., rubbed in.

Cases in which the passage of a catheter through the urethra has been difficult, or in which it has not been easy to get into the bladder from the perineum, have been treated by exposing the commencement of the urethra through a suprapubic wound, and then passing the catheter from behind forwards and tying it in the urethra for a day or two.

Hæmorrhage from the bladder is often free. It is checked by hot water, by sponge-pressure, or by plugging the bladder with gauze until the next day.

The bladder wall is completely sutured when hæmorrhage has stopped, when there is no urethral or prostatic obstruction, when the wall is healthy. The superficial wound should only be partly united, the lower end being filled with gauze, so as to provide against leakage from the bladder wound. If the recti are divided, they are sutured to the pubes again. The peritoneum is to be avoided, but should it be wounded, the rent is sewn up before opening the bladder. Nevertheless, the peritoneum has been widely opened before incising the bladder in order to remove a very large stone. In such a case the rest of the peritoneal cavity and the intestines are protected by sponges, and, after the bladder has been sewn up again, are well flushed with water.

Acute Prostatitis—Prostatic Abscess.

Acute inflammation of the prostate is an uncommon sequela of gonorrhœa. It goes on to suppuration, especially in tubercular subjects; and the abscess may involve only a group of follicles, or the whole gland within its capsule. Other causes are septic catheterism or stone.

The symptoms are pain, increased on micturition, defæcation, and pressure. Retention of urine may be due to spasm or to pressure. Suppuration will be indicated by the severity of the fever and other symptoms. Fluctuation ought not to be waited for, as the patient is suffering much from pus within the tense capsule; and when the fluctuation becomes evident, the abscess will probably have extended.

Hot fomentations and leeches to the perineum, and suppositories of opium, morphine, or belladonna, are first tried, combined with a purgative. An anæsthetic will be probably required in order to pass a catheter. But an incision into the prostate through the perineum is the only way of affording real relief, and it should be undertaken early.

Subacute and chronic prostatitis are due to the same causes as acute. In addition, gout and tubercular disease may cause it, or these causes may play a part in combination with gonorrhœa, stricture, and stone. The special signs are local pain and tenderness, with thread-like casts of the prostatic ducts, which may be seen by collecting the morning urine, or mucus is squeezed out into the urethra during defæcation.

A chronic or definitely tubercular abscess may burst into the rectum or through the perineum. It is incised and scraped out by an incision through the perineum, and this should be done before it bursts and forms a fistula.

Prostatic calculi may arise in the ducts, and then the chronic prostatitis persists until the calculi are removed.

Enlargement of the Prostate—Prostatic Hypertrophy.

After the age of fifty the prostate tends to increase in size, mainly by additions of fibrous tissue. This is a senile change which normally gives no trouble. In a certain proportion of cases there is, however, a marked increase of vascularity along with the increase of fibrous tissue, the change being supposed by some to be connected with a general arterial sclerosis. When the enlargement is sufficient to cause symptoms, it may be uniform or chiefly of the middle or of one or both lateral lobes. The enlarged middle lobe forms a sort of collar round the commencement of the urethra, or a small nodule blocks the urethra like a valve, or a sessile or pedunculated tumour growing from the middle lobe projects into the bladder and grows to the size of the closed fist. Enlargement of the prostate may show itself in several ways.

1. *Pain and Increased Frequency of Micturition.*—The bladder is not quite emptied, and the urine remaining behind becomes slightly stale from commencing ammoniacal fermentation. Phosphates are precipitated in the prostatic pouch, and this sets up a slight degree of cystitis and increased frequency of micturition.

2. *Atony of the Bladder.*—The bladder is not emptied, sensory nerves are dulled, muscular fibres are weak, and the bladder becomes more and more like an inert sac. The bladder, immediately after the patient supposes himself to have emptied it, is found distended half-way or more towards the umbilicus with 'residual' urine.

Belladonna relieves the pain and irritability of the bladder, carbonate of soda or boric acid increases the acidity, ergot improves the contractile power. If the urine is drawn off once a day, and the bladder washed out, decomposition and the formation of phosphatic calculi are prevented. And there may in this way be produced a gradual restoration of the complete expulsive power of the bladder.

3. *Retention.*—An old man is suddenly seized with retention, accompanied by great pain. He has probably noticed that he has passed his urine of late with a weak stream; he has

drunk more fluid than usual, and has been prevented from passing his water until the bladder was distended, and he then found himself unable to do so. The pain is a sign that the bladder has not been so distended before, and that the cause of the retention is the valvular action of the enlarged prostate. A soft rubber catheter is passed with great gentleness, for the urethra is much congested, and bleeds most freely. If there is any difficulty, an anæsthetic may be given, or the patient's bladder may be aspirated by puncture above the pubes. Retention is avoided afterwards by passing water every four hours, and especially shortly after drinking.

4. *Hæmorrhage.*—A patient suffers from hæmorrhage from the urethra, from intermittent attacks of hæmaturia, from hæmorrhage into the bladder, which becomes filled with blood-clot. These conditions occur spontaneously, but they are especially aggravated by rough catheterism. The patient is treated by rest, purgatives, and full doses of belladonna and ergot. A collection of blood-clot in the bladder is removed by washing out through a cannula with as hot water as can be borne. Repeated attacks of hæmorrhage are treated by suprapubic or perineal drainage, the bladder at the same time being explored with the finger in order to exclude a malignant growth.

5. If the urine becomes alkaline, and loaded with thick muco-pus, a calculus may form in the pouch behind the prostate. The patient becomes exhausted by the pain and frequent micturition, and extension to the kidneys follows. The latter is shown by wasting, anæmia, albuminuria, and fever, with a dry brown tongue.

The palliative measures to be adopted are: Sounding under an anæsthetic to exclude a stone, washing out the bladder twice a day, perineal or suprapubic drainage by tying in a tube, and later by passing a catheter through the fistula twice a day.

The measures directed to diminishing the size of the prostate are: Prostatectomy or partial removal through the perineum or above the pubes, cauterization of the prostate through the perineum, or division of the vasa deferentia, equivalent to castration.

Prostatectomy.

The objections to this operation are its severity in an old and weak patient, the liability to hæmorrhage—primary or secondary—the causation of severe eczema spreading from around the wound, and the persistence of a fistula. On the other hand it offers a means of cure which has proved very successful, except in the most aged and exhausted.

The suprapubic operation is employed when a large calculus has to be removed. The perineal operation is less severe. It affords an admirable drain for a prostatic pouch, the urine is not so likely to irritate and cause a dangerous eczema, and a fistula is of less importance, as it only leaks during micturition. Instead of removing much of a growth which is very vascular, the cautery point may be used to puncture the mass in several places, so that shrinkage of the organ beyond the actual mass removed is brought about.

Suprapubic Prostatectomy, see p. 420.

Transverse Perineotomy—Exposure of the Prostate through the Perineum.

With the patient in the lithotomy position, a semilunar incision is made, with its convexity forwards across the centre of the perineum, the two horns ending on either side of the anus. On deepening the incision, all the blood-vessels are seen and clamped. The rectum and anus are retracted backwards without being injured, and then there is exposed the membranous and prostatic urethra, the prostate, and, above it, the post-prostatic pouch, or the vesiculæ seminales. The details of any further steps are now all in view after clamping the bleeding-points, and hence the great advantage over the lateral lithotomy operation, which has of late years passed out of use.

The membranous urethra is incised longitudinally, the bladder reached and explored, a stone crushed and removed, part of an enlarged prostate shelled out, an abscess scraped, the post-prostatic pouch incised and drained. Instead of these measures, the enlarged lateral lobes of the prostate may be stabbed at several points by the cautery.

Resection of the Vasa Deferentia, equivalent to Castration—Vasectomy.

A shrinkage of the enlarged prostate in an old man follows this operation, just as the normal prostate shrinks in young animals when castrated. Within a week of the operation, micturition improves, and a comfortable life may be restored to the patient.

The advantage is that this operation can be borne by weak and aged patients. The resection of the vasa through an incision in the median scrotal raphe behind is a very small operation, and seems to be as effectual as the castration.

If the enlargement is unilateral, only one side need be operated upon, and the incision is made over the vas as it crosses Poupart's ligament and the pubes.

The objections to the operation are that sexual desires and feelings are lost. This may have already taken place owing to the patient's age, and so the operation may not make much difference. But, at any rate, a full explanation has to be given the patient.

Patients have, however, died shortly after the operation, having first suffered from dementia. This may be due to the operation coming too late to prevent this result of the long prostatic obstruction, in causing destruction of the kidneys. But in some of the cases dementia has followed as a direct result, or the patient's complaints have given trouble. In other cases no improvement has followed.

Before contemplating this operation, the presence of calculus must be excluded. The patient should be at least seventy, and be too weak to stand prostatectomy or cauterization through the perineum.

New Growths of the Bladder.

Benign.—The benign growths of the bladder are papillomata, and are really rare. Many cases of malignant disease consist at first mainly of superficial papillary outgrowths, the infiltration of the wall of the bladder becoming apparent at a later stage. Such papillomata have been called benign, have been said to recur after removal, and to end in becoming malignant. But this account is not in accord with observations on new growths elsewhere. All the evidence goes to show that benign growths do not become malignant, that growths which are malignant are so from the first.

The papillomata which are most certainly benign are multiple, and may cover the interior of the bladder, producing a villous condition, or a papillomatous degeneration of the mucous membrane. If completely removed, a good prognosis as to cure may be made. The single papilloma is always an object of suspicion, and it cannot be pronounced benign unless completely removed, and the submucosa beneath shown free from infiltration.

Malignant.—Malignant disease may appear first as a papillomatous mass, having long processes floating in the fluid, like the fimbriated extremity of the fallopian tube or the tentacles of an anemone. On microscopic examination of one of these processes, it is found to be made up of simple connective tissue covered with transitional epithelium. But in the base of the outgrowth carcinoma is found, at first superficial to, and then invading, the muscular wall. Hence the examination of a detached fragment from the surface gives a wrong impression.

Epithelioma may commence as an ulcer with indurated edges and base, sometimes shown to be directly caused by the irritation of a stone or other foreign body.

Sarcoma commences in the wall of the bladder, and quickly extends beyond the organ.

The chief sign of a new growth of the bladder is hæmorrhage. If there is intermittently a little blood at the end of micturition, with slight bladder irritation and no thickening of the wall, the growth may be benign. If there is much hæmorrhage without enlargement of the prostate, and pain and induration in the bladder wall felt on bimanual examination, malignant disease is indicated.

Hæmorrhage may also be due to a calculus, enlarged prostate, renal nephritis, or malignant disease of the kidney. Sometimes a bit of the growth may be passed per urethram, but if it presents benign characters, no definite conclusion can be drawn as to the nature of the tumour.

Cystoscopy, if the urine remains clear, may reveal the position of a growth ; but a negative result is of no value.

The persistence of hæmorrhage and the absence of a stone are sufficient to indicate the necessity of a suprapubic exploration, whether the growth can be seen through the cystoscope or no.

Multiple papillomata are plucked and scraped away. If a single papillary mass is met with which has not yet deeply infiltrated the wall, the growth must be outlined by an incision around it, and the whole cut out with the healthy tissue beneath. A circumscribed epithelioma has been excised from the anterior wall after stripping off the peritoneum. When anything more than mucous membrane is cut away, the wound must be sutured.

Unfortunately, malignant disease of the bladder is generally beyond removal. Frequent irrigation, perineal or suprapubic drainage, or both combined, along with opium or morphine against pain, are the palliative measures. Before death, rupture may take place into the peritoneum, or ulceration into a loop of the intestines. Attempts have been made, however, to cure extensive malignant disease by excising the whole bladder, including the trigone, and inserting the ureters into the rectum.

Malignant Disease of the Prostate appears in two forms. One is a rapidly enlarging and soft tumour, which before death may press on the urethra or rectum, and so raise the question of suprapubic drainage and colotomy. It is generally a carcinoma, occasionally a sarcoma.

Sometimes the prostate remains small and hard, a ‘scirrhus,’ and the main tumour may pass unrecognised ; but secondary growths occur, especially in the bones, having the prostatic arrangement of cells.

CHAPTER XXXIV.

SURGERY OF THE RECTUM.

In the healthy adult the anus is a canal about ½ inch in length within the grasp of the sphincters. It is lined by mucous membrane, which is separated from the external skin by a pale line. It can be detached from the sphincter muscle, being connected only by loose connective tissue, in which lies the ring of hæmorrhoidal veins. These veins join the superior hæmorrhoidal veins by branches which pass obliquely through the muscular wall of the rectum. The branches of the superior hæmorrhoidal artery run parallel to one another in the muscular wall, and end in capillaries which anastomose in the sphincter muscles with the inferior hæmorrhoidal branches. The bloodvessels, therefore, in the mucous membrane and submucous tissue of the anus are only fine capillaries, but they become enlarged to vessels of a considerable size when thrombosis and subsequent inflammation have produced a large pile. The lymphatics from the internal margin of the anus pass to the inguinal lymphatic glands, those of the rectum to lymphatic glands in the meso-rectum.

The anus has a rich nerve-supply, and any disease is attended by pain. Its nerves have the special function of reflexly tightening or relaxing the sphincter when stimulated by the presence of fæces. Stretching the anus invariably causes struggling, unless the patient is deeply anæsthetized. Whilst the anus is so sensitive, the rectum above seems to have scarcely any nerves of common sensation. Cancers form in the rectum above the anus, and grow to a considerable size quite unnoticed, until some other symptom draws attention to the disease. The rectum is examined with the patient on the side or kneeling. The finger, covered with soap or oil, is pressed against the orifice, and the patient told to bear down. In this way the finger passes into the rectum without causing pain to the normal anus.

If, however, a fissure, etc., is present, it may be impossible to pass the finger without first administering an anæsthetic. The finger feels the grasp of the anus for ½ inch, but cannot perceive piles if the veins are simply dilated and not thrombosed. Such dilated veins are seen by drawing apart the buttocks, and telling the patient to bear down gently.

In the male the prostate is felt just within the anus on the anterior wall, and, by pressing the finger forwards, the arch of the pubes and the triangular ligament. Above the prostate are the vesiculæ seminales and the termination of the vas deferens on either side. In the female the cervix uteri and part of the fundus are felt, and a rectal examination is therefore a convenient method for a young unmarried woman. At the side the ischio-rectal fossæ, the border of the levator ani, the obturator foramen, and the ischial tuberosities and rami, are to be noted. Behind, the sacrum and coccyx up to the promontory are perceived. The rectum has folds, and a band about 3 to 4 inches up indicates the fold of peritoneum. In examining high up in the rectum, pressure is at the same time made on the hypogastrium. By this bimanual method a sigmoid or ileo-cæcal tumour may be detected, especially under an anæsthetic. A speculum allows the folds of the mucous membrane in the anus and lower end of the rectum to be examined. By putting the patient in the genu-pectoral position, air enters and distends the rectum.

The passage of a tube or catheter upwards does not yield reliable information, for the tube will not generally pass beyond the promontory, but coils up there. Statements as to the passage of a long tube into the sigmoid flexure of the colon are not generally credited. If, however, the descending colon can be distended with water or air, obstruction in the sigmoid flexure is negatived.

Injury.—Pointed bodies accidentally or intentionally forced into the rectum may perforate into the peritoneal cavity. Fatal peritonitis is the inevitable result unless the peritoneal cavity be at once washed out, and the wound in the gut closed.

Foreign Bodies, after passing through the alimentary canal, may lodge in the rectum, and start ulceration and the formation of an ischio-rectal abscess. A fish-bone is the commonest. A gallstone may reach the rectum; an enterolith or calculus may form there. Foreign bodies have been inserted in order to relieve pain. Removal takes place after dilatation of the anus, added to which an incision can be made backwards towards the coccyx.

Fæcal Impaction.—A collection of hard fæcal material sets up irritation, mucous discharge, and frequent but small motions. The collection has become so great as to give rise to the supposition of a tumour. The finger can indent a mass of fæces, which it cannot do in the case of a tumour. Fæcal impaction is relieved by enemata of oil and water, combined with piecemeal removal, using a lithotomy scoop, the handle of a spoon, or the finger.

Imperforate Anus.

The abnormalities of the rectum are due to arrested development of the hind-gut, and its failure to open on the skin. The proctodæum, or epithelial involution, is very slight in man. A septum separates the dimple of the anus from the cavity of the gut, or there is no anus, and the blind end of the gut is an inch or more from the surface. The gut instead may open into the urethra of the male, into the vagina, or in the loin, or at the umbilicus when Meckel's diverticulum still remains patent. The absent or imperforate anus may be noted at birth, or attention is first drawn to the matter by the failure of the meconium to appear. After birth air is swallowed, also milk, and a rapid fermentation goes on, causing the intestines to be distended with gas. The child dies from intestinal obstruction; rupture of the intestines generally takes place into the peritoneum, and only exceptionally does the gut burst on to the surface.

In rare cases the reflex vomiting fails to exhaust, and defæcation by the mouth is established, and continues indefinitely.

The condition is relieved by cutting into the bowel, dilating with forceps or the little finger, and afterwards keeping up the dilatation by the daily passage of the finger or bougie. If the blind end cannot be found, the incision is continued back to the coccyx, so that the gut may be sought for in the hollow of the sacrum. The coccyx may be cut away to give more room, so that even if the blind end is as high as the brim, and within the peritoneal cavity, it can be reached and pulled down. It must be quite exceptional that an abdominal section is required, and colotomy in cases which cannot be reached by the perineal operation has rarely been successful.

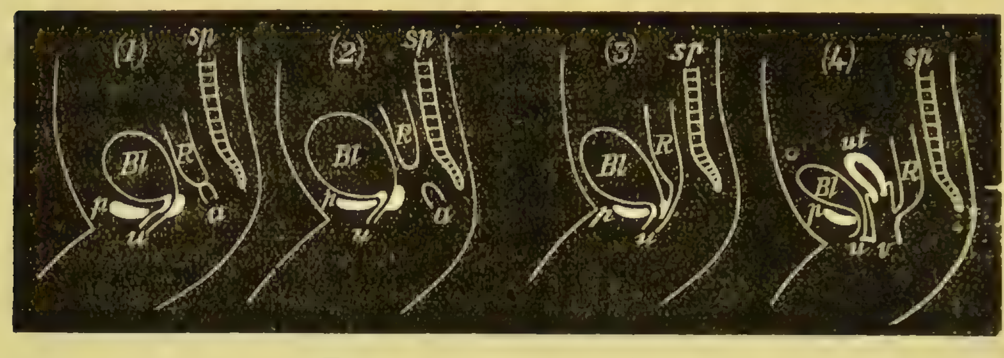

FIG. 90.—IMPERFORATE ANUS.

(1) Rectum separated from anus by thin septum; (2) blind end of rectum some distance from anus; (3) rectum opening into male urethra; (4) rectum opening into vagina: *Bl*, bladder; *R*, rectum; *p*, pubes; *u*, urethra; *a*, anus; *v*, vagina; *ut*, uterus; *sp*, spine.

Inflammation and Ulceration of the Rectum.

Acute Inflammation of the Rectum is rare; it arises from extension of erysipelatous inflammation through the anus, or is due to gonorrhœa. The sphincter is divided backwards towards the coccyx, and the rectum frequently irrigated.

Chronic Inflammation and Ulceration are caused by dysentery and syphilis. The former disease spreads to the rectum from the large intestines, syphilis generally from the anus upwards.

Tubercular Ulceration is generally secondary to pulmonary disease, caused by the bacilli in the sputa, which are swallowed. Occasionally in women there is a purely local tubercular ulceration, lupus of the rectum.

A tubercular ulcer in a phthisical patient perforates the mucous membrane, and causes an internal blind fistula. It may burrow further and form an abscess, which bursts through the skin, and gives rise to a fistula in ano. A further extension may take place, and produce multiple fistulæ or caries of the coccyx. A tubercular fistula should always be operated upon, unless the patient is almost moribund. He is relieved from much annoyance and pain, has an improved appetite, and especially is able to take open-air exercise, all of which have a beneficial effect on the state of the lungs. The anus is dilated or divided backwards, ulcers are scraped and antisepticized, fistulæ are excised. Iodoform or mercury ointment is afterwards introduced. If healing is delayed or there are signs of recurrence, a speculum may be passed, the mucous membrane cocainized, and then lactic acid (10 per cent. to 70 per cent.) applied, or the ulcers may be seared with the cautery.

Lupus is treated in the same way, viz., scraping and cauterization, after which ointment is introduced. The ulceration heals for a time, but is very apt to recur.

Stricture of the Rectum.

The annular stricture is a narrowing of the wall outside the mucosa. It occurs in women about 2 inches within the anus, and the mucous membrane between it and the anus is normal. It has been compared to a gonorrhœal stricture of the urethra, but its cause is unknown.

Syphilitic ulceration, commencing from the anus, spreads up, and afterwards greatly narrows the rectum.

Among the exceptional causes of simple stricture are dysentery, bilharzia, and the impaction of foreign bodies. Stricture is cured by gentle dilatation with a bougie and the introduction of mercury ointment. A stricture which dilates with difficulty is divided back towards the coccyx, including the sphincter.

Abscess and Fistula in connection with the Rectum.

A perianal abscess forms immediately beneath the skin, superficial to the fibres of the sphincter ani, and, when neglected, gives rise to an external blind fistula. The abscess is caused by the irritation of dirt, sweat, or worms.

A perirectal abscess forms in the submucous tissue above the sphincter and internal to the levator ani, and after bursting, an internal blind fistula is produced, having its opening above the internal sphincter, and running up under the mucous membrane. The causes are tubercular, syphilitic, dysenteric, or cancerous ulceration, the irritation of scybala or of foreign bodies, such as fish-bones.

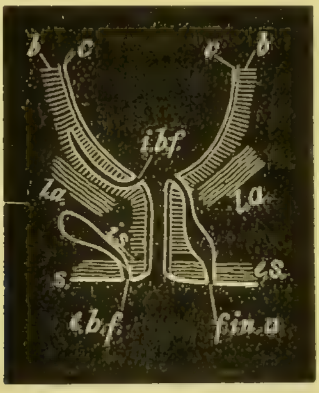

FIG. 91.—ANAL FISTULÆ.

e b f, External blind fistula ; *f in a*, fistula in ano ; *i b f*, internal blind fistula ; *s*, skin ; *e s*, external sphincter ; *i s*, internal sphincter ; *l a*, levator ani ; *b*, muscle coat of rectum ; *c*, mucous membrane.

A fistula in ano has an external opening on the skin, and an internal one in the anal canal. Commonly the external opening is behind the front margin of the anus, and the track of the fistula runs back subcutaneously to the posterior aspect of the anus, and then passes through the fibres of the sphincter into the anal canal. If there are two external openings, the fistulous tracks will generally be found to join behind, so that there is only one channel through the sphincter, hence the name 'horseshoe' fistula.

The external opening may be found in the perineum, in the scrotum, or even in the groin, owing to the burrowing of pus forwards beneath the skin. On carefully slitting up even multiple fistulæ, there is generally found to be only one fistula through the sphincter.

Ischio-rectal Abscess.—Pus may collect in large amount in the loose connective tissue and fat of the ischio-rectal fossa. At first the signs are pain, brawny induration, and redness to one side of the anus, and, on introducing the finger, a swelling is felt between the rectum and the ischial tuberosity. It arises from the external and internal causes above given, also from damp or cold seats, and is specially common and severe in alcoholic patients. The abscess bursts both through the skin and into the rectum.

By means of an incision an abscess is prevented from becoming large and a fistula from forming. Any inflammatory induration about the anus or rectum is sure to end in suppuration, and therefore a small incision into it should be made at once, without waiting for such an extension of the abscess as to yield fluctuation. The incision is made to the side of the anus, the abscess cavity cleared out, and dressed daily with gauze. The dressing of the cavity is essential, otherwise a fistula will inevitably be set up. Healing must take place from the bottom, and the skin meanwhile be prevented from closing.

A Fistula is carefully laid open, and if it runs through the fibres of the sphincter, a probe-pointed director is passed, and the muscular fibres divided towards the surface. The fibres must always be cut transversely, never obliquely, and only one incision must be made. The sphincter ani in a woman must not be divided on its anterior aspect, where the fibres decussate with those of the vagina. These precautions are necessary in order to avoid the continuance of incontinence after healing. If the wall of the fistula is thick or infiltrated with tubercle, as much as possible is excised. Stretching of the anus and scraping of the fistulous track through the sphincter may suffice in a woman with a weak sphincter.

The wound must be dressed firmly with gauze strips, and will take three or four weeks to heal. Attempts at shortening this period by excision of the fistula and suture of the wound have not been successful, for the wound is sure to become septic. As the wound gets small the strip is smeared with iodoform or other ointment.

The only sign of an internal blind fistula may be rectal irritation and the discharge of muco-pus. After well dilating the anus, a speculum is passed, and the course of the fistula found by a probe; the mucous membrane is then slit up the whole length of the fistula. Iodoform or mercury ointment is afterwards introduced.

Other Fistulæ connected with the Rectum.—A prostatic fistula follows on an abscess. A transverse incision is made in the perineum, the cavity scraped, and calculi, etc., removed. A recto-vesical fistula is generally cancerous in origin, owing to an extension of the growth from one organ to the other. It is rarely due to ulceration extending from a pouch of the bladder containing the stone. It used to follow the now obsolete practice of tapping the bladder through the rectum.

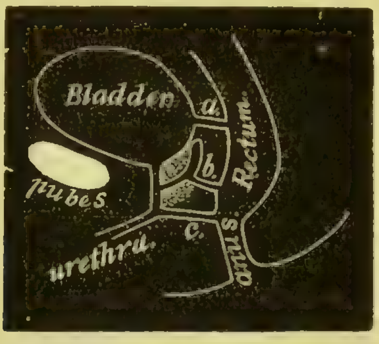

FIG. 92.—RECTAL FISTULÆ.

a, Connecting rectum and bladder; *b*, connecting rectum and prostate with urethra; *c*, connecting rectum and urethra.

A recto-urethral fistula is generally congenital, but occasionally follows a perineal abscess due to urethral stricture. It may be cured by a perineal incision, paring and suture of the rectum, and the dilatation of the urethra.

Recto-vaginal fistula occurs in women as a complication of labour or secondary to cancer.

A fistula may communicate with the rectum from some abdominal or pelvic disease. A dermoid cyst arising in the ovary, broad ligaments, Douglas's pouch, or between the male bladder and rectum, may discharge into the rectum oily fat, hair, etc. In the same way a hydatid cyst, a pelvic, perityphlitic, or psoas abscess, an extra-uterine fœtation, may discharge into the rectum. After a preliminary exploration of the rectum, the cause of the fistula must be removed. Where this cannot be safely done, a temporary colotomy may be required to divert the fæces until the fistula has closed.

Piles, or Hæmorrhoids.

The inferior hæmorrhoidal veins form a circular plexus beneath the mucous membrane of the anal canal and of the adjacent skin. The veins can be seen by drawing apart the buttocks and telling the patient to bear down. But even when varicose the veins do not become fully apparent, except during and after defæcation, after sitting over a pan of hot water, or most completely after dilatation of the anus. The veins are covered by mucous membrane and by skin ; hence, when the veins become dilated, those covered with mucous membrane are called internal piles, and those covered by skin external, but there is no line of demarcation. If the veins are only dilated, they can be seen, but not felt. When thrombosis occurs, inflammation is set up by the clot in the wall of the vein and around, so that gradually a tumour is developed, consisting of a thick wall, with a clot in the interior partly vascularized. The pile thus formed is primarily of venous origin, and connected therefore only with large veins ; but as the inflammatory thickening goes on, there is a continuous increase in the arterial supply, until a large artery can be felt supplying the pile. The tumour thus formed becomes prolapsed, and the grasp of the sphincter obstructs the return of venous blood ; the result is venous congestion and thrombosis, followed by ulceration and hæmorrhage, or even sloughing.

Piles are primarily due to a congenital weakness of the vein walls, and, like other congenital conditions, may be met with in several members of the family, along with varicose veins in the leg, or varicocele. The immediate causes of piles are a sedentary occupation, muscular debility and anæmia in young men and women, constipation, and chronic eczema due to lack of cleanliness. Pregnancy and other abdominal tumours, phimosis, stricture, stone and enlarged prostate, or any cause of strain in micturition and defæcation, are predisposing causes. Portal obstruction from cirrhosis of the liver is only exceptionally attended by the development of piles, and it is a popular error to regard piles as necessarily a sign of plethora and of portal obstruction.

When simply dilated veins, piles may remain stationary, only causing discomfort if there is constipation, or a collection of sweat about the anus, or if there has been some excess in diet or alcohol, accompanied by insufficient exercise. When thrombosis has occurred, the patient is subject to repeated attacks of inflammation, followed by periods of quiescence, but with each attack the piles increase in size. With the ulceration there is loss of blood, producing anæmia.

As an exception to the general rule, an attack of inflammation may cause an obliteration of the veins, and so a spontaneous cure; but such cases are very rare, and even then the patients have been prevented from taking active exertion for a long time. All patients would consult their own comfort by submitting to an early removal; the only exception is in women advanced in pregnancy, from fear of exciting abortion. In a case of cirrhosis of the liver, the removal of piles is not attended by danger, and much relief will be afforded, for such patients are really anæmic, and not plethoric.

The palliative treatment of piles consists in cleanliness, laving with cold water, sponging the anus after defæcation, the application of an astringent ointment, a daily motion, walking exercise, and the avoidance of alcohol and long sitting. A prolapsed and strangulated pile is reduced by gentle pressure, preceded by the application of hot fomentations or an ice poultice. Excision is the only certain method of curing piles and preventing recurrence. It is an operation without danger, and the pain afterwards is absent; or if there is some for a few days, it is less than that which existed beforehand.

Excision of Piles.—The patient is prepared by a purge, followed by an enema. If the enema is not returned, the rectum is washed out, after the patient is anæsthetized. The patient may be held in the lithotomy position, or on the left side, the left leg being extended, and the right well flexed. The patient must be first anæsthetized until the palate is paralyzed, hence ether preceded by nitrous oxide gas is essentially the anæsthetic to be used. When the patient is fully anæsthetized, not before, the surgeon dilates the anus by separating the fingers or thumbs antero-posteriorly and laterally. The force is applied steadily, so as not to tear the sphincter, but the dilatation must be complete. It is the most important step of the operation, for otherwise piles will be overlooked. The dilatation should be completed as a preliminary step; then the patient can be kept less deeply anæsthetized, without any struggle occurring. Moreover, the dilatation of the sphincter ensures relief from tenesmus until healing. The piles are separately ligatured by seizing them with a volsella or ring forceps, cutting with scissors along the line separating the skin and mucous membrane, and the pile is then separated bluntly from the sphincter. The base of the pile is transfixed by drawing it down, so as to include as much of the mucous membrane as possible, but no skin nor muscle. The pedicle ligature is tied tightly, and the pile cut away some distance beyond the ligature, so that there shall be no chance of the ligature slipping. The process is repeated until all the varicose mucous membrane has been cut away. A morphine suppository ($\frac{1}{3}$—$\frac{1}{2}$ grain) is inserted, and a pad applied with a T-bandage. The bowels should be moved by an aperient on the second or third day, and after that every morning, the anus being washed and dressed immediately after. The patient should not get up for ten days, and may in severe cases remain in bed with advantage for three weeks. No plug is needed when the piles are tied as described, after dilating the anus. It causes much discomfort, and prevents the escape of discharges.

The piles may be all clamped and then seared off with the cautery; this requires an extra assistant, unless the bellows are worked by the foot. The stump must be seared with the cautery at a dull-red heat, not charred. It is easy to disturb the seared surface and set up bleeding again. Hence the finger must not be passed into the anus after the cautery has been used.

When the piles are large and accompanied by prolapse, the whole ring of piles and mucous membrane together may be separated from the skin and sphincter, brought down, and the mucous membrane above the ligatures fixed to the skin. There is more bleeding in this operation, and it is therefore not suitable for women, for in them a good deal of blood has been lost. It is apt to be followed by contraction, which is undesirable, unless there has been previously much weakening of the sphincter by prolapse.

The mistakes likely to be made are: overlooking of piles from insufficient dilatation of the anus, hæmorrhage owing to imperfect ligature, late hæmorrhage, and pain caused by scybala when the bowels are allowed to remain confined, especially after the use of opium. Stricture results from the ligature or burning of skin or the sphincter, and a bougie may then have to be passed daily for a year or more.

Prolapse of the Rectum.

Prolapse of the rectum is common in young children, from irregular feeding, constipation, and worms. The prolapse consists of an involution of the bowel, which, being grasped by the sphincter, suffers from venous congestion, ulceration, and hæmorrhage. It is returned, after oiling it, by gentle pressure, generally under an anæsthetic. If the child is properly fed or the worms got rid of, the tendency to prolapse disappears. If the anus has become patulous, a temporary stitch may be inserted in the skin in front and behind the anus, so as to leave just room for the fæces between. A pad is placed over the anus, and held firmly by a strong T-bandage carried over the shoulders, not simply up to the waist. The child should have a daily motion lying on its side, and the mother or nurse should for a time or two press back the anus. Mercury and chalk or worm powders, astringent injections and suppositories may prove useful adjuncts.

Polypus or piles are complicated by prolapse of mucous membrane. When prolapse persists after their removal, linear proctotomy may be done by passing a speculum and searing the mucous membrane by making four or more longitudinal streaks with the cautery, without going deeper than the mucous membrane. This is intended to narrow the lumen, and to fix it to the submucous and muscular coat. Bad cases require excision. The mucous membrane is separated from the skin and sphincter, pulled down and the proximal end stitched to the skin, after which the excess is cut away. Some contraction is desirable to prevent relapse, and this is prevented from becoming excessive by the passage of a rectal bougie for as long a period as necessary.

Prolapse of the rectum may be secondary to that of the uterus, and is cured by fixing up the latter organ.

Polypus of the Rectum.

A simple or mucous polypus is composed of the submucous connective tissue, covered by normal mucous membrane. Its cause is unknown. It generally appears about puberty, especially in girls. It is discovered by causing slight hæmorrhage, by protruding through the anus, or by also inducing prolapse. The pedicle is transfixed and tightly ligatured before removal, for it contains a small artery.

Multiple Polypi.—Bilharzia ova cause polypoid masses to form in the rectum, and occur in Egypt.

Multiple polypi are also seen in young male adults. The rectum, as far as can be felt by the finger, is full of soft polypoid masses, which bleed, discharge mucus, and set up pain and prolapse. The condition extends up into the colon, attacks more than one member of the family, and is followed by cancer, from which the patient dies some time between the ages of twenty and thirty.

The multiple polypi may be scraped away, cut off, or burnt down, in order to afford temporary relief.

Simple Fissure of the Anus.

This is a small ulcer, lying in the folds of the mucous membrane of the anus. It does not heal because there is a tag or external pile at its outer end, which forms a little pocket. In it fæces lodge and keep up irritation. Sharp, cutting pain and tenesmus are felt, which become very severe during defæcation. The typical fissure is produced during the passage of a scybalous mass, which tears down a fold of mucous membrane. If the tag or external pile is frozen and snipped off, the fissure will heal at once.

One or more fissures may be caused by inflammation or ulceration of the neighbouring skin. Or it may be due to some internal cause—piles, syphilitic, tubercular, dysenteric, or malignant ulceration.

Malignant Disease of the Rectum and Anus.

Epithelioma of the anus occurs in old patients, and may follow on eczema and pruritus. As it advances, the glands in the groin become enlarged. A primary syphilitic sore or tertiary gummatous induration must first be excluded. All the disease must be freely removed by excising the skin and sphincter. Removal of the enlarged glands in the groin may also serve to prolong the patient's life in slow-growing cases. Subsequent contracture is largely prevented by bringing down the mucous membrane, by grafting the wound with skin as soon as it becomes covered by granulations, and by the passage of bougies.

Carcinoma of the rectum grows from the epithelium of Lieberkühn's crypts, and the cells of the new growth are arranged in a tubular fashion. It is remarkable for the widely different ages at which it occurs. It has been seen in a child, in young adults under or just over twenty, and until the age of forty it must be looked upon as a very malignant type of cancer, for which very little can be done. In older patients the cancer is much less malignant ; the results of complete removal are then favourable.

On examination of the rectum, the finger meets with a hard ulcer with raised and everted edges, or there is an indurated ring, or the lumen has become much narrowed and the growth slightly prolapsed, so that it feels somewhat like a cancerous cervix uteri. It is an important point to make out whether the growth is freely movable, or whether it is fixed in front to the bladder and prostate or to the vagina. If the finger can pass beyond the growth, the back wall is palpated in the search for glands in the meso-rectum. If the growth is high up, it can only be reached by bimanual examination; the mobility is again an important point to decide upon. The gut below is apt to be widely dilated ('ballooned') owing to paralysis. Excision of the rectum is undertaken when the growth is still freely movable, and this can only be completely made out under an anæsthetic. Excision is contra-indicated when the growth involves the wall of the bladder and the peritoneum. It must be postponed whenever there is any fæcal obstruction. When, however, obstruction has been relieved, either by the passage of a tube through the growth or by colotomy, the desirability of excision may be considered. As excision of the rectum is a severe operation, old age and debility render death from shock likely. For excision the patient may be placed in the lithotomy position, or in the left lateral position, or in a prone position similar to that in which the cadaver is placed for dissecting the gluteal muscles, the pelvis being raised by a bolster, and the knees resting on chairs. The incision is made from the anus to the coccyx. If there is not sufficient room, the incision is extended along the left side of the coccyx and sacrum. More room still is obtained by cutting off the coccyx at its junction with the sacrum, or by a division of the sacrum as high up as the third sacral foramina. Instead of cutting away the bone, it may be simply turned aside to the right, and is afterwards replaced. The gut is now separated bluntly from the sacrum, bladder, vagina, and, if necessary, the fold of peritoneum is opened and the gut pulled down. Thus all the diseased bowel is freely separated without contaminating the main wound with fæces. The proximal end of the bowel above the growth is now clamped. If the anus is involved, the whole of the distal end of the bowel is cut away, and the proximal brought down and carefully sutured to the skin before the clamp is taken off. If the lower end of the bowel and the anus are healthy, the diseased portion is cut away and the proximal end sutured carefully to the distal end. A tube is inserted into the anus, and surrounded with gauze, in order to conduct the fæces away from the wound, and this is done before the clamp on the proximal end is taken off. The coccyx and lower end of the sacrum are removed or sutured back into position, and the cavity in the hollow of the sacrum is dressed with gauze for a few days until danger from leakage at the line of suture has passed away. The bowels should be moved on the third day, to prevent the collection of scybala, and a bougie must be passed until the tendency to contracture ceases.

Palliative Treatment of Cancer of the Rectum.—A regular action of the bowels, so as to prevent accumulation of fæces above the growth, along with the administration of opium and morphine for the relief of pain, are the chief points.

By means of a catheter carefully passed through the narrowed bowel, the gut above may be washed out. The passage through the growth may be even dilated very gently with the finger, but without using force, for cancer tissue is very friable, and fatal perforation may easily be set up. The washing out may be done daily, and with the use of morphine and iodoform suppositories much relief may be given.

Inguinal colotomy is rarely necessary when the growth is low down, unless fistulæ have formed which open into the bladder or on to the skin. A commencing communication with the bladder is indicated by the escape of gas from the bladder during micturition, the urine begins to smell, contains bacilli from the colon, later on actual fæces. Colotomy is also required for intestinal obstruction. Inguinal colotomy, even although perfectly accomplished, fails to give relief from the pain caused by the pressure and irritation of the growth on the nerves of the pelvis, nor is there good ground for believing that it slackens the rapidity of the growth. Some patients view the artificial anus as an additional trouble.

CHAPTER XXXV.

SURGERY OF THE MALE GENITAL ORGANS.

Malformations.

Length of the Prepuce.—The commonest malformation is a long prepuce, which induces phimosis. Occasionally the prepuce is naturally so short as to leave the glans exposed.

Hypospadias.—When the folds on the under aspect of the penis fail to unite to form the penile urethra, the condition is called hypospadias. The urethra may end beneath the glans penis at the level of the corona. This is a condition which gives no trouble. When the urethra opens just in front of the scrotum, some urine dribbles down, and sets up inflammation of the skin of the scrotum. The penile portion of the urethra can be closed in by a plastic operation. The groove on the under surface of the penis is turned into a canal lined by epithelium, by making a longitudinal incision parallel to the groove on each side, raising the flaps towards the groove, and suturing them together, epithelium inwards, raw surface outwards. To cover in this raw surface, flaps of skin are brought together and sutured along the middle line. In difficult cases success has only been reached by setting up perineal drainage for a time, so as to protect the wound from urine.

Complete Hypospadias.—The male genital organs are arrested before they have differentiated from the female. The urethra opens into a cul-de-sac in the perineum, a small channel leads up to the uterus masculinus. The scrotum is ununited, and each half contains a testis, from which the vas deferens passes up to the external abdominal ring. The imperforate penis is much longer than the clitoris; no uterus is to be felt on rectal examination. The points above noted distinguish the child as being a male. The female sex is practically free from abnormality; descent of the ovaries does not occur before birth, and in after-life only as a hernia. All children of doubtful sex should be educated as males, not as females. The urine has to be passed squatting. Such a person may get children.

The penis may be bound down to the scrotum, and have to be raised.

Epispadias and Extroversion of the Bladder.—Owing to an arrest of development in the ventral wall of the allantois, the front wall of the bladder and the abdominal wall, which should cover it, may be absent, as well as the body of the pubes, so that the rami are separated and the corpora cavernosa do not fuse together. The child appears with a reddish prominence, extending from the position of the umbilicus downwards, ending in a gutter between two prominences formed by the corpora cavernosa of the penis. The umbilicus is absent; the red mass is the posterior wall of the bladder, bulged forwards by the intestines behind it, which are separated from the bladder wall only by a thin layer of peritoneum. The ureters open on two prominences, and the urine can be seen discharging in jets at intervals.

During infancy no special difficulty arises if the child is well looked after and kept clean. On the other hand, severe eczema may ensue from linen too rarely changed.

As the child gets to be a year old, the choice of treatment lies between fitting a suitable urinal or in doing a plastic operation. The former avoids a dangerous operation, and presents no great difficulties if the child wears a kilt. Moreover, after going through an operation, the most successful issue will not avoid the use of a urinal, for no plastic operation has ever yet prevented the incontinence. Plastic operations are attended by the danger of erysipelas, owing to the impossibility of preventing urine from coming in contact with fresh wounds, hence a fatal result has followed in many cases.

A plastic operation consists in raising the edges of the posterior wall, and uniting them in the middle line, then bringing flaps from the abdomen or scrotum to cover this in. The epispadias is similarly treated. In order to more easily bring the edges together, the sacro-iliac synchondroses have been divided, and the pubic rami approximated. Unfortunately, after successful union the mucous membrane tends to prolapse from abdominal pressure, and to reproduce the deformity, for the skin, especially of the scrotum, freely yields.

It has been also attempted to transplant the ureters into the intestines. This is unlikely to be a successful operation, for even if done the urine would irritate the rectum by decomposing, and septic material would spread up the ureters to the kidneys.

Injuries to the Penis.

The penis has been wounded, or even cut off. If cut off during erection, hæmorrhage is so severe as to produce acute anæmia.

The penis has been thrust through rings which have only with great difficulty been cut through. Boys tie string or wire tightly round the penis ; there results a great swelling of the glans penis and prepuce, resembling paraphimosis, which may go on to gangrene. The constricting band is found at the bottom of a deep groove, partly overlapped by the swelling.

The penis, on account of some tight squeeze, has been dislocated either into the scrotum or towards the groin. The penis is felt beneath the skin, and the urine escapes by means of a sinus. The penis is easily reduced after a suitable incision.

The penis may be cut off as part of a brutal method of producing eunuchs. The result is a very tight stricture at the cut end, which has to be overcome by some form of catheterism, and as a result of which the patient may suffer in the bladder and kidneys from the obstruction.

The same result has followed an amputation of the penis badly done.

Phimosis.

Phimosis is a constriction of the orifice in the prepuce, as a consequence of the prepuce being overlong. At birth the prepuce can be withdrawn over the glans, but owing to the irritation of the urine on the long foreskin, an eczema is set up, which diminishes the opening in the prepuce. The effects of a long prepuce and of phimosis are pain and straining in micturition; the child gets into the habit of pulling on the prepuce, and later on to habits of masturbation. A preputial calculus or merely phosphatic concretions may be deposited between the prepuce and glans, and lead to ulceration and extravasation of urine, tracking back into the scrotum, or a calculus passing along the urethra may be arrested beneath the prepuce. The straining during micturition produces inguinal hernia, prolapse of the rectum and umbilical hernia. It is impossible to cure these conditions until after circumcision. A neglected phimosis has caused hypertrophy and dilatation of the bladder, sacculation of the kidneys, and death from suppression of urine. In older children, reflex effects from a long foreskin or partial phimosis may take place, especially when it allows the retention of smegma. The chief of these are: a pain in the region of the hip-joint, simulating hip-joint disease, asthma, premature sexual excitement, sterility from impeded coitus, greater liability to venereal disease. Phimosis may be acquired later from venereal sores.

Circumcision consists in removing freely the skin behind the corona. The skin is drawn well forwards, and the glans pressed back and protected by the thumb and finger, or by the blades of forceps, while the foreskin is being cut off. The mucous membrane is then completely separated from the glans up to the corona, and united to the skin by sutures. Any small vessels which can be seen are best tied. The vessels of the frænum should not be divided. A flake of wool with collodion is applied round the line of suture, and this dressing may be strengthened by a strip of strapping. The dressing is removed the next day by sitting the child in a bath, after which it is kept clean and dusted with boric acid powder. The complications after circumcision are due to the removal of insufficient skin, so that the scar closes over the glans and restores the phimosis. Oozing of blood may ensue sufficient to disturb the parents; this is prevented by carefully tying with fine ligatures every vessel, for it is impossible to keep up pressure, or to tie a vessel afterwards, unless with a repetition of the chloroform. Some ulceration occurs before healing in many cases, dressings are quickly soaked with urine, and are a source of irritation; therefore they are best omitted, except just at first. Tuberculosis and syphilis have been inoculated by the saliva of Jewish circumcisers similarly diseased, from which the glands in the groin may be affected.

Paraphimosis.

Paraphimosis is a constriction of the glans penis at the corona, produced by an abnormally tight foreskin being drawn back over the glans. The more severe cases are due to complication with gonorrhœa, which causes additional swelling of the prepuce and glans. The œdematous glans is squeezed, and the prepuce then pushed forwards; failing this, a division of the band is required under gas by passing a curved bistoury beneath the constriction on the dorsal aspect and cutting out. If left alone, ulceration and sloughing commence at the level of constriction. Circumcision should then be done, omitting sutures, and the patient made to sit in a permanganate bath. Chronic paraphimosis is attended by œdema of the tissues about the frænum, forming a bulbous mass, for which circumcision is also the remedy.

Venereal Sores and Phagedena.

The majority of the sores are treated by mercurial wash or iodoform powder, combined with internal remedies, if syphilis is diagnosed. Occasionally venereal sores become phagedenic; this is generally due to direct inoculation from sores similarly affected. The phagedena must be arrested; if not, the glans is destroyed, the urethra opened, and sinuses form. Pure carbolic acid is applied, or, under anæsthesia, the ulcer and the zone around is destroyed by the actual cautery, avoiding, if possible, the urethra, and then dressed with iodoform. Sufficient opium is given to relieve pain and erections. The cautery can be used more exactly, and its action is not prolonged; it is therefore preferable to caustics.

Healing ulcers of the glans and meatus are bathed, and the dressings saturated with carbolized oil (carbolic acid 1, olive oil 40) to prevent pain and sticking, the penis and dressings being kept in a waterproof bag.

Diabetic Ulcers.

Sores and ulcers which tend to become gangrenous may form in a diabetic, owing to the irritation from the crystals of sugar and from organisms. It is most important that the diabetes should be recognised and treated, and that all operations should be avoided.

Gonorrhœal Warts.

These are multiple papillomas, generally forming round the corona, less commonly on the skin of the prepuce, or extending to the scrotum. They are probably inoculated from similar warts.

They are snipped off under anæsthesia, and the base cauterized, after which black wash is freely applied to prevent recurrence.

Papilloma of the Penis.

A single cauliflower-like growth occurs on the penis of men past middle age; it may be traceable to venereal irritation, but this is not necessarily the case. It is distinguished from epithelioma by the absence of an indurated base, of ulceration, and of enlarged glands. It tends, however, to become epitheliomatous when remaining untreated, and is therefore freely excised as soon as possible.

Epithelioma of the Penis.

This may arise from any cause of irritation, such as a venereal discharge, the irritation from phimosis, or from soot in chimney-sweeps. It may assume a papillomatous or ulcerative form. In the former case it has to be distinguished from a simple papilloma, in the latter case from a syphilitic sore. The increasing ulceration, induration, and enlargement of lymphatic glands distinguish epithelioma from papilloma; from a syphilitic sore it is distinguished by its slow development and the failure of antisyphilitic remedies.

Amputation through the Penis.—Removal of the Penis.

Epithelioma of the penis, when still localized, is removed by amputation through the penis at least $\frac{1}{4}$ inch behind the extreme edge of the induration. The disease always spreads more rapidly in the corpora cavernosa. A circular incision is made through the skin, then a catheter is inserted, the penis transfixed above the catheter, and the corpora cavernosa cut through transversely; the corpus spongiosum and urethra are then divided $\frac{1}{4}$ inch in front of the cavernosa after withdrawing the catheter. The urethra is split horizontally, and its dorsal half stitched to the skin on the dorsum, and the lower half to the skin underneath. Any narrowing of the new meatus is prevented by catheterism; if the stump is short, a vulcanite prothetic apparatus may be made to conduct the urine away from the clothes.

If the whole penis is involved, the incision begins on the mons veneris, encircles the penis in front of the scrotum, and is then continued backwards along the raphe of the scrotum to the perineum; the scrotum is then split into two halves up to the urethra, the urethra is cut transversely, so as to leave it long enough to be stitched to the hinder end of the wound. The corpora cavernosa are now separated from the ramus of the pubes and ischium by means of a knife and raspatory, the vessels being clamped. The scrotum is finally united again, and the urethra fixed in the perineum.

If the glands in the groin are enlarged, the incision should be continued laterally along Poupart's ligament, and a vertical one added if necessary. Thus the lymphatic glands and the lymphatics leading from the penis can be dissected out all together.

Inflammation of the Corpora Cavernosa—Chordee.

Inflammation is a common sequela of gonorrhœa, causing the condition of chordee, in which there is irregular erection, the penis being curved, owing to the corpus spongiosum not taking part in the swelling. Very rarely the inflammation is more acute, and actually goes on to abscess. Chordee generally yields to a hot bath and a dose of opium at bedtime. Bromides may also be given. A chronic indurated mass in the penis is generally a gumma, and yields to antisyphilitic remedies, but sarcoma may occur.

Priapism.

Priapism is a persistent erection from dilatation of the bloodvessels. It may be due to an excitation of the roots of the nervi erigentes, and thus may complicate fracture of the spine. It may also be a reflex excitation from the bladder or urethra by a calculus.

Inflammatory Diseases of the Scrotum.

Œdema of the scrotum may be part of general dropsy ; it may be a local œdema, owing to lymphatic obstruction, and tend to become elephantiasis of the scrotum.

Elephantiasis due to lymphatic obstruction chiefly occurs in tropical countries from *Filaria sanguinis hominis.* The thickening involves the skin and subcutaneous tissue, and this may be dissected off, leaving the unaltered testes to be re-covered by the skin around the root of the penis.

Eczema of the scrotum is generally due to the effects of sweat and dirt in the folds. In later life it tends to set up an epitheliomatous growth. This is especially the case in chimney-sweeps, from the irritation of the soot.

Erysipelas of the scrotum is favoured by the causes producing eczema. It also complicates venereal disease. The scrotum sloughs away, leaving the testes hanging in the wound. By sitting in permanganate baths, and the use of iodoform, healing rapidly ensues, the testes being soon covered in by surrounding skin.

Primary syphilitic sores and mucous tubercles form on the scrotum, for which the chief local application is black wash.

The scrotum is a site for sebaceous cysts ; sometimes they are multiple and of various sizes, from a pea to a walnut ; no ill effect need follow, but, if necessary, they can be incised and scooped out.

Malignant Disease of the Scrotum.

The chief malignant disease of the scrotum is epithelioma, generally preceded by some eczema, and occurring frequently, although not exclusively, in chimney-sweeps. It is a growth relatively favourable for early excision. The epithelioma slowly affects the glands, which must be also excised with the intervening lymphatics.

Scrotal Fistulæ.

Urethral stricture gives rise to an abscess, which, extending into the scrotum, bursts and forms a fistula. Calculi have made their way into the scrotum. A sinus may be formed on account of suppuration about a testicle.

Varicose Veins.

Occasionally large varicose veins are found. They have no connection with varicocele. If one be punctured, free hæmorrhage may ensue. This is arrested by transfixing the bleeding point with a hare-lip pin and twisting a figure-of-eight ligature around. The portion of the skin of the scrotum affected with varicose veins may be excised.

Lymph Varix.

If the lymphatics are obstructed in the course of elephantiasis, vesicles may form and burst, setting up an eczema. The remedy is excision.

The Testis.

The testis is supplied by a double set of arteries and veins: the spermatic and those running with the vas deferens. The obliteration of one set of vessels is fully compensated by the other, but the obliteration of both sets necessarily involves gangrene of the testis, for there is no anastomosis with the scrotal vessels.

The nerves of the testicle are derived from the spinal cord at the level of the lowest dorsal and first lumbar nerve roots, *i.e.*, from the same level as those of the kidney.

Neuralgia of the testis may be due to some local disease of the organ, or, on the other hand, to renal calculus, gout, lithiasis, or some lesion of the spinal cord or nerves at the above level.

Injuries of the Testis.

A crush may completely destroy the testis, which changes into a fatty or fibrous mass, and should this happen on both sides, it is equivalent to castration.

A divided vas deferens must be united by suture. If not, the testis is rendered functionless. The testis may then shrink, or, remaining of the same size, undergo fatty metamorphosis.

The testis may be dislocated into the loose connective tissue at the root of the penis, or into the groin, or protrude through a lacerated wound. It is easily replaced.

Torsion of the spermatic cord may occur from a slight squeeze when the testicle hangs freely in the tunica vaginalis, attached by a mesorchium. If the torsion is sufficient, strangulation is set up; then much pain is complained of, the patient has nausea or vomiting, and, if the swelling is close up by the ring, it is difficult to diagnose it from hernia. On incising the tunica vaginalis, the twisted pedicle is found with the testis much swollen and blue, or actually gangrenous. Excision is required, except in early cases, when the pedicle is untwisted and the testicle fixed by sutures. A more complete torsion is sufficient to entirely occlude the bloodvessels, and then fatty atrophy ensues. Torsion of the testis is used in France, called ‘bistournage,’ as a method of castrating animals. If septic organisms are circulating in the animal, they settle down in the clot at the point of torsion, and cause suppuration, sloughing of the testis, and septicæmia. If in the ligature of the enlarged veins during the operation for varicocele those belonging to the vas deferens are also included, the same results will follow as after complete torsion.

Abnormalities of the Testis.

When the testis is not in the scrotum, it may be retained, or have descended into a wrong position, or be absent.

The testis may be retained in the inguinal canal, whilst the external ring is closed. In this position the testis is liable to repeated injuries, whilst an interstitial hernia tends to form. Less often the testis lies on the iliacus muscle within the internal abdominal ring. It is in this position less subject to injury, but is apt to become the seat of malignant disease in later life.

Ectopia testis is said to be due to the misdirected action of fibres of the gubernaculum testis. Fibres attached to the ischium draw the testis into the perineum as in the pig. Fibres connected with the deep fascia in Scarpa's triangle draw the testis over Poupart's ligament, or even through the crural canal.

The testis, although in the scrotum, may be retroverted, so that the epididymis lies in front, and the tunica vaginalis behind. Should a hydrocele or hernia form in such a case, the testis will lie in front.

Absence of both testes, anorchism, is indicated by an ill-developed penis, the scanty formation of hair on the pubes and chin, a figure approaching the female type, especially a narrow chest and broad pelvis, small muscular development, puerility, a cracked voice. Such symptoms may also be met with where the testes, although in the scrotum, are soft and atrophied.

Monorchism is indicated by the presence of an unusually large and well-formed testis.

Treatment is called for on account of liability to injury, or on account of the accompanying hernia. If the misplaced testis is small and ill-formed, whilst there is a normal testis on the opposite side, the deformed testis should be removed. When, however, the opposite testis is not in the scrotum or is ill-developed, a misplaced testis should be put into the scrotum, where it can be held for a time by a suture attaching it to the adjacent skin of the thigh.

Orchitis.

Acute orchitis is traumatic in origin, or complicates mumps in the adult. Subacute and chronic orchitis may be due to similar causes, also to gout or malaria. Besides these, syphilis and tubercle will be specially referred to.

The treatment varies with the cause.

Epididymitis.

Acute epididymitis is one of the commonest complications of gonorrhœa. It is the more likely to be induced if the patient drinks, or if the urethra is actively treated by strong astringents and the passage of instruments. There is great pain and swelling, the scrotum appearing red and brawny. The patient can hardly bear the testicle to be touched, but it is easy to perceive that the chief swelling is in the globus minor of the epididymis. The vas deferens is also swollen. The affection may be unilateral or bilateral. With the swelling the urethral discharge is less, but it increases again as the swelling diminishes. When not due to recent gonorrhœa, it follows a drinking bout, and often gleet is found connected or not with the formation of a stricture. Salicylate of soda is given in 20-grain doses, and after about the fourth dose the pain is relieved; there is no need for opium or a depressing line of treatment, like the administration of antimony. The patient stays in bed, keeps his bowels open, and paints belladonna extract and glycerin thickly over the scrotum. He should not take alcohol, and any local urethral treatment should be temporarily intermitted. Later on he gets about with the testicles suspended.

Abscess of the Testis.

An acute orchitis terminating in the formation of an abscess is a rare complication of the specific fevers, of mumps, of pyæmia.

A subacute or chronic abscess is, excluding tubercle, caused by gonorrhœal epididymitis, but it is of quite exceptional occurrence when no active instrumentation or application of drugs is carried out during the acute stage of gonorrhœa. The use, moreover, of aseptic bougies for the dilatation of a stricture prevents the formation of an abscess.

An abscess is incised as soon as it is detected, and the pus removed, so that neither a hernia testis nor a sinus is likely to form, and castration is thus avoided.

Syphilis of the Testis.

Secondary syphilis causes an orchitis, generally bilateral, although not necessarily simultaneous. An enlargement of the testis itself occurs without pain, the testis when handled feels hard; it can be squeezed without causing pain—indeed, proper testicular sensation is much impaired or lost. There is nearly always some fluid in the tunica vaginalis. The vas deferens and epididymis are not involved by the syphilis, but they may be affected by a concurrent gonorrhœa. The secondary syphilitic orchitis is an interstitial inflammation, which soon yields to the use of mercury, both generally and locally.

A syphilitic gumma attacks the testis by preference, whilst tubercular disease affects the epididymis. A gumma forms a swelling of the testis, not extending to the vas or glands. It softens and breaks down. If iodides and mercury fail, the gumma is incised and scraped out. A gumma may continue enlarging in spite of the treatment by drugs, and is then liable to be mistaken for malignant disease. The diagnosis is made by a preliminary incision. When, however, the disease is not confined to a single mass, but has spread beyond the testis to the scrotum, castration is the best treatment.

Tubercular Testis.

Primary tubercular disease usually begins in the head of the epididymis, and only secondarily involves the testis. It is generally unilateral at first, but becomes bilateral in advanced cases. When, however, there has been previously gonorrhœal epididymitis, the tubercular disease may commence in the globus minor. It is a subacute or chronic affection, somewhat painful, the vas deferens becomes gradually enlarged, and in advanced cases the vesicula seminalis also. Caseation may take place, and a sinus forms, or a hernia testis. The treatment is at first general, viz., cod-liver-oil, and other tonics; but the most likely cure, whenever the patient shows a general tendency to tuberculosis, is a sea-voyage. If caseation commences, the formation of a sinus should be anticipated by incision and erasion. Castration is indicated when the disease continues to extend up the vas deferens. Further indications will be found in the fact that the condition is unilateral, and that there are signs of tuberculosis in the lungs or elsewhere.

Not only has the testis been excised, but the spermatic cord has been pulled out, and the vesicula seminalis incised and scraped. Double castration has also prolonged life when the disease has been bilateral.

Fungus or Hernia Testis.

Fungus testis is the result of an extension of malignant disease of the testis to the skin of the scrotum.

Neglected disease of the testis, tubercular, gonorrhœal or gummatous, in which an abscess has been allowed to form and burst through the skin of the scrotum, is followed by a prolapse of the testis, which becomes covered by granulations.

When the testis is only partly destroyed, the granulations are scraped away and the skin drawn over the testis by strapping. When already nearly destroyed, the testis is removed.

Malignant Disease of the Testis.

Malignant disease is characterized by a progressive enlargement of the testis without signs of inflammation. Effusion occurs into the tunica vaginalis, at first serous, but later, when the growth has reached the sac, blood-stained. At an early stage the vas deferens, and then the lymphatic glands in the groin, enlarge. The origin is often attributed to an injury, but also some slight injury may draw attention to the tumour. Malignant tumours are sometimes sarcomas, sometimes carcinomas, but in either case the glands are infected at an early period. The tumour may be fibrocystic, or mixed sarcoma and carcinoma. A dermoid cyst may lie quiescent in the testis for years, and then assume malignant features. Malignant disease of the testis may be confused with a gumma or with a hæmatocele. The diagnosis is completed by an exploratory incision.

When castration is done for malignant disease, the skin of the scrotum is freely removed, the vas deferens cut across as high up as possible, and the lymphatic glands excised from the groin.

Fluid in the Tunica Vaginalis Testis.

Occasionally fluid collects in the sac of the tunica secondary to abdominal disease, tubercle, cancer, ascites from cirrhosis, or in connection with chylous ascites.

Hydrocele.

Congenital hydrocele is a collection in a sac the funicular process of which has not been completely shut off, so that the fluid can with greater or less difficulty be squeezed back into the peritoneal cavity. It is generally seen in quite young children, and usually disappears spontaneously with the complete closure of the funicular process. Therefore cold lotions are employed as a temporizing measure, and straining from phimosis is removed by circumcision. If, however, the hydrocele persists, and especially if complicated by the presence of a hernia, excision is required, the steps being similar to the operation for congenital hernia.

The cause of the common form of hydrocele is unknown, but, by obstruction of the lymphatics leading from the serous membrane, absorption is prevented. It most often occurs in old men, and is unilateral, but it may be bilateral, and in young men. A smooth, pear-shaped, elastic mass fills the scrotum, and is found to be dull on percussion and translucent when the skin is stretched. The testis lies below and behind, and is marked by the sensation caused to the patient by pressure. The cord is felt to be free above. The sac is primarily unilocular, but in consequence of inflammation set up by repeated tappings or injections may become multilocular. In advanced cases micturition becomes difficult owing to the penis being sunk in the scrotum.

Treatment.—Multiple punctures with a tenotome in order to let the fluid escape into the surrounding tissue, whence it may be absorbed, is only suitable for the thin-walled hydrocele of children in whom no hernia is present; but a free incision is to be preferred, for suppuration and sloughing may follow the multiple punctures.

A hydrocele is tapped whilst the patient is lying down by grasping the tumour behind with the left hand, so as to make both the skin and sac tense. Then a trocar and cannula are plunged sharply in at right angles to the surface, about the middle of the tumour. Superficial veins are avoided; the trocar is not pushed deep enough to injure the vessels in the cord, and if the lower end of the sac is avoided, the testis need not be punctured.

The most certain plan of curing a hydrocele is to freely incise the swelling, wash out the sac, stitch the sac to the skin, and fill the cavity daily with gauze. Healing from the bottom soon occurs. A less certain plan is to incise, wash out, cut away part of the sac, and sew up the wound except for a drain at the lowest end, which is kept in for a week.

The treatment by injection is both painful and uncertain. It is an entirely unsuitable treatment when the sac wall is thick. The treatment by injection is followed very often by severe pain, sufficient even to cause vomiting, and the patient has to keep his bed. Even if apparently cured, fluid is apt to re-collect some months later. A troublesome tenderness of the testis may remain. Many kinds of fluids are used, all calculated to set up slight inflammation. Tincture or liniment of iodine, or a mixture of the two, may be injected after emptying the sac; the iodine is well manipulated in the sac, and then most of it is squeezed out through the cannula. One drachm of pure carbolic acid dissolved in a little water or glycerin may be injected, manipulated over the sac, and the coagulated fluid allowed to escape. Carbolic acid has the advantage of being an anæsthetic. A solution of cocain, containing not more than ½ grain, may be injected three minutes beforehand to relieve the immediate pain of an iodine injection.

Fatty Hydrocele.—The fluid contains fat, and spontaneously coagulates on standing. It is due to a leakage from the chyle vessels, and may be accompanied by chylous ascites, or be the only lesion. The sac must be washed out and drained; a part may be also excised.

Hæmatocele.

A typical hæmatocele follows on a hydrocele. The testicle, not slipping as usual out of the way, is easily squeezed, and, as a consequence, blood is extravasated into the sac. A chronic inflammation then ensues, which leads to thickening of the sac wall, gradually increasing to be upwards of 1 inch in thickness; meanwhile the blood-clot becomes dry and laminated, or a brown paste. More rarely a chronic inflammation of the testis and epididymis precedes a hæmatocele. Also occasionally a blow or strain may produce a hæmatocele without any preliminary hydrocele having existed, but generally the extravasation of blood in such cases is intercellular, and not into the tunica vaginalis, and is absorbed. The previously existing hydrocele indicates that the absorptive channels are already blocked. A hæmatocele may be due to malignant disease of the testis fungating into the tunica vaginalis. A hæmatocele should be incised, and the blood-clot turned out at the earliest possible moment. If the sac wall has become very thick, it is excised, and that portion covering the testicle scraped; the cavity is afterwards dressed daily with gauze. The testicle will be found behind and below, soft and normal, thus distinguishing the case from malignant disease with extravasation of blood or fungation of the growth into the tunica. However, in neglected cases, where sinuses have formed after suppuration, castration will be the best remedy for hæmatocele.

Encysted Hydrocele of the Epididymis.

The commonest kind is a freely movable pedunculated cyst between the head of the epididymis and the testis in the position of the hydatid of Morgagni. When tapped, fatty fluid containing sperms may be drawn off. The cyst is tapped, the fluid examined, and the inner wall of the cyst scratched with the trocar. If the cyst refills, it is excised.

Cysts of the Testis.

Cysts of the testis are uncommon. They are usually blood-cysts. A dermoid cyst may occur, congenital in origin, afterwards enlarging, to become malignant.

Varicocele.

Varicocele is formed by a dilatation and an elongation, so as to become tortuous, of the veins of the pampiniform plexus. These veins belong to the vascular Wolffian body in the embryo, and are always more completely obliterated on the right side, as transverse sections of the cord will show under the microscope. On the left side the veins can, after puberty, be felt when the scrotum is relaxed. Each vein may become as large as a pencil, and form a mass seen and felt above the testis, yielding an impulse of fluid, and diminished by lying down. In consequence of hard work, residence in hot climates, or of some failure in nutrition, a dragging or aching pain begins. The patient having discovered the veins, the varicocele may form the basis of a neurosis, or afford an opportunity to a recruit for malingering. Hence a varicocele has to be removed before a man can enter the public services. If a varicocele gives no trouble, there is no need for active treatment, for no complications are likely to arise. Cold douches, active exercise, regular motions, and a well-fitting suspender suffice. Varicocele is nearly always on the left side, occasionally a small one coexists on the right.

When, however, the dilatation of the veins extends into the testis, this organ begins to get soft, and unless the varicocele is then excised, the testicle will atrophy. After excision of the varicocele, the soft testis becomes firmer again. The weight of the veins may make the testis hang so low as to cause that organ to be often squeezed.

Excision of a Varicocele.—The part is shaved, the patient thoroughly and repeatedly cleans himself in a hot bath, the skin is prepared as usual by an antiseptic compress, and, before making the incision, the penis is wrapped up. The skin just below the external ring is transfixed after being pinched up, and the fascia picked up between two forceps and divided. The veins are separated by the fingers and forceps, and drawn out. The vas deferens and the accompanying deferential vein and artery must be carefully separated, and on no account be injured. The spermatic artery is often so included in the plexus of veins that it is divided. This is of no consequence, provided that the proximal end is ligatured before it is relaxed; otherwise it will retract and bleed freely.

One ligature transfixes the veins close to the external ring, the other near the testis, after which the intermediate mass of veins is excised, and the stumps approximated by tying together a free end of each ligature. This draws up the testis from its dependent position. Oval portions of an elongated scrotum have been excised, but this is unnecessary; the skin soon shrinks if the testis is drawn up in the way described.

Patients have died of septicæmia owing to the infection of the wound. The scrotum is very difficult to clean, hence the necessity for repeated hot baths beforehand, also the incision should be made as high up as possible. Sloughing of the contents of the scrotum has resulted from a complete ligature of all the veins, including those of the vas, and death has followed. Minor troubles arise from the knot of a ligature not being absorbed, or from neuralgic pain being felt in the scar. Varicocele cannot recur if a considerable length of the whole plexus is removed, for there is no new formation of veins; but when the veins are simply ligatured, anastomosis may take place through or around the site of the ligature.

Tumours of the Spermatic Cord.

Hydrocele of the cord is a cyst generally situated in an unclosed portion of the funicular process. It is also conjectured to arise near the testis in a vas aberrans, or organ of Giraldes. It is cured by excision.

Lipoma is the commonest fatty tumour, and grows from the subperitoneal fat. It descends gradually to the scrotum whilst a pedicle extends up into the spermatic canal. It is distinguished from an omental hernia by the absence of a sac. But there are transitional forms, in which the subperitoneal lipoma draws down a process of peritoneum, or the subperitoneal fat hypertrophies to form a tumour around a pre-existing sac. A lipoma is excised, and the pedicle tied as high up as possible. Sarcoma of the cord forms a rapidly growing tumour; having excluded a gumma, the growth is freely excised, the whole cord and testis being sacrificed if necessary.

Castration and Section of the Vas Deferens.

Castration is an operation only employed for the removal of local affections, with the possible exception of some cases of hypertrophy of the prostate in old men. Unilateral castration is not followed by any special symptoms, provided that the remaining organ is normal. Bilateral castration before puberty produces a eunuch characterized by a type of development intermediate between the male and female. Thus, the shoulders remain narrow, but the pelvis widens. Little or no hair grows on the face and pubes; the voice remains high. After puberty, bilateral castration may create little change, except sterility, erection remaining. On the other hand, the patient's mind may be depressed by the loss of these organs, and this may be followed by confirmed melancholia. Or the patient may be seized with maniacal fits of hate, directed against the surgeon.

In cases of enlarged prostate, the testicles may be removed in the same way that animals are castrated—by pressing the testis against the bottom of the scrotum, and cutting down upon it until it protrudes, when it is ligatured off. The testis can also be removed by cutting down upon the cord as it crosses Poupart's ligament, and pushing up the testis into the wound.

Instead of removing the testis, a piece may be cut out of the vas deferens. This can be done on both sides through a single wound in the posterior raphe of the scrotum. The vas is pressed towards the wound, and drawn out by a hook. The vas can also be divided on one side as it crosses Poupart's ligament.

Castration for Local Disease.—When the cord is also involved, an incision is carried from the external ring down to the bottom of the scrotum, and the whole separated from the skin of the scrotum without encroaching upon the opposite side. If the skin of the scrotum is implicated, it is freely removed by including the diseased area in an oval incision. The cord is then transfixed and tightly ligatured before cutting away below. Or a clamp may be applied, the cord divided below the clamp, and the separate vessels ligatured on the face of the stump. In either case the spermatic artery must be firmly secured before the cord is let go. If not, it retracts into the inguinal canal, so that an extension of the incision is required in order to get at the artery, or there may occur concealed hæmorrhage into the peritoneum, supposing a protrusion of peritoneum into the cord to have been divided.

When the cord is involved, the incision is extended up to the internal ring, and as much of the vas removed as possible, along with any enlarged glands. Indeed, the spermatic artery can be ligatured above the point where it joins the vas deferens. The vas may then be drawn on until it gives way close to the prostate. The corresponding vesicula seminalis, if affected similarly with tubercle, may be removed through a perineal incision.

CHAPTER XXXVI.

SURGERY OF THE FEMALE GENITAL ORGANS.

Examination.

THE patient is placed at first on her left side, semiprone, her left arm drawn backwards beneath her, the nates close to the edge of the couch, and the knees well flexed. The dorsal position is necessary for a more thorough examination. The patient lies on her back, her buttocks on the edge of the couch, well raised by a pillow, the knees apart, and the feet resting on two stools. When under an anæsthetic, the full lithotomy position is adopted. The genu-pectoral position, in which the buttocks are raised from the semiprone position, is serviceable by taking off abdominal pressure from the internal genitals, so that the vagina becomes distended by atmospheric pressure.

The vagina is examined by the finger, which is placed on the perineum and slid forwards over the posterior fourchette, so as to avoid the clitoris. The examination of the uterus, ovaries and pelvis is made by combining the pressure of the finger in the vagina with that of the other hand on the hypogastrium.

The rectum is examined in unmarried women, and the vagina is not interfered with unless there is good cause. In other cases a rectal examination is supplementary to the vaginal one.

A cylindrical speculum with a glass mirror is commonly employed. The labia are separated by the thumb and forefinger, and the well-greased end of the speculum is passed by pressing the posterior fourchette backwards towards the

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perineum. Then, by an upward and backward pressure, and small movements of rotation, the cervix is got into the end of the speculum. Daylight or artificial light is allowed to enter, or a small electric lamp can be passed up. For further examination, and for retraction during operations, duck-billed and other specula of metal are used. A speculum or retractor of wood or bone may be used to protect against the cautery.

The External Genitals.

Injury.—Severe hæmorrhage has occurred after the first coitus. If bleeding continues, the source must be exposed under anæsthesia, and the bleeding vessel in the torn hymen tied. More severe injuries and extensive lacerations follow rape. The wounds are thoroughly disinfected, and then sutured.

From kicks or falls astride lacerations are produced, and hæmatomas of large size form in the labium majus. Rest and cold lotion may suffice for the hæmatoma, or owing to continuous hæmorrhage, suppuration, or the formation of a cyst, it may become necessary to incise the swelling, turn out the blood-clot, ligature the bloodvessel, and fill the cavity with gauze.

Varicocele of the Labium.—The veins of the labium may during pregnancy become much increased, so as to form a large tumour, from which there is great danger of hæmorrhage. Small masses of veins may be destroyed by the cautery, but the base of larger masses is transfixed by a pin, and then surrounded below the pin by an elastic band. The mass can then be cut away without loss of blood, and the vessels of the base ligatured or cauterized before the elastic band is relaxed.

Cyst of the Labium.—A cyst forms by obstruction of a duct of the vulvo-vaginal gland, and contains glairy mucus. It may form a pendulous tumour, or gradually distend the labium, so as to partly resemble an inguinal hernia. A cyst is irreducible, has no impulse, and does not occupy the external abdominal ring. The cyst is completely dissected out.

Abscess of the Labium.—An abscess may be secondary to a cyst, or be primarily due to venereal disease.

Vulvitis—Vulvo-Vaginitis.—All the more severe forms are due to gonorrhœa, although slighter cases may be caused by dirt alone. An acute purulent inflammation is met with in little girls, and the pus contains the same micro-organisms as gonorrhœa, and it is transmitted from one little girl to another, but is not caused by coitus or attempted coitus. It is easily stopped by cleanliness, isolation, and the application of lotio nigra.

Gangrene.—Noma, or phagedenic ulceration, appears in weakly children following upon one of the specific fevers. The gangrenous slough must be cut away, and the organisms at the spreading margin destroyed by a strong antiseptic. Any fresh extension is similarly treated; *e.g.*, pure carbolic acid can be painted on. Iodoform and permanganate baths are freely employed during healing.

Phagedenic sores in the adult are of venereal origin, nearly always complicating a syphilitic sore. Hence, in addition to the immediate and active local treatment, mercury is required internally.

Lupus.—There is a rare form of progressive ulceration which appears in women, and which at first has to be distinguished from tertiary syphilis. The diagnosis is completed by finding tubercles in the ulcer. The ulcer is treated by scraping and the cautery. It is apt to heal for a time, and then breaks down again. Any reappearance of ulceration is the signal for another attack. Mercury ointment or lotion is usually the only application of any service.

Pruritus-Kraurosis.—A patch of skin becomes the seat of dry eczema and of intolerable itching. Topical applications having failed, the affected skin is dissected away, and if there is a deficiency it is replaced by skin-grafting.

Elephantiasis.—An enormous overgrowth of a labium may be caused by chronic inflammation and lymphatic obstruction. It is especially met with in hot climates, due to lymphatic obstruction by filariæ. The mass is excised.

Papilloma.—Gonorrhœal warts may cover the vulva, extend back around the anus, and ascend to the pubes.

They are shaved off, and the base cauterized. A single papilloma, like a cauliflower, grows from or in the neighbourhood of the clitoris, and forms a mass between the labia. The older the patient, the more likely is a malignant ulceration to develop.

Syphilitic Sore.—It occurs generally on the labium majus, less often on a labium minus, clitoris or about the urethra. It may be multiple. It is diagnosed by its induration, accompanied by enlargement of the inguinal glands and the occurrence of the rash. It is besides distinguished from epithelioma by the short duration, and by the improvement under mercury. Age is untrustworthy, as both epithelioma and chancre are met with in both young and old women.

Epithelioma.—An epithelioma may arise from the labium or clitoris under one of two forms: a papillomatous mass with an indurated base, or an excavated ulcer with everted and indurated edges. The growth is excised, and the incision extended to the inguinal lymphatic glands, which are also completely removed, as well as the tissue between containing the lymphatics.

The Female Urethra.

A catheter can be passed in the left lateral position, the meatus being seen on separating the labia. It can also be passed in the dorsal position. The patient's knees are well flexed and somewhat abducted. The index-finger within the vagina feels the arch of the pubes and the urethra, and the catheter is then passed with the other hand along the finger into the meatus. It is better, however, to have the meatus plainly in view, rather than to fumble in the dark. An ordinary male catheter is used. In order to be retained, it must have an expanding or bulbous end.

The bladder is explored by a sound, with a finger in the vagina or the hand on the abdomen.

The urethra is easily dilated to admit the finger. This may be done sometimes without an anæsthetic, especially after labour. Cocain, 20 per cent., painted on, and a saturated pledget of wool inserted into the urethra, may be a sufficient anæsthetic, or a general anæsthetic is required.

Gentle and gradual dilatation by bougies is best; there is then no rupture of the sphincter, and no danger of incontinence following. The interior of the bladder and front of the uterus are examined with the fingers. Fine catheters may also be passed into the ureters. Foreign bodies and calculi may be extracted or crushed before removal.

Urethral Caruncle.—This is a little papilloma, vascular, very sensitive, at the orifice of the urethra, which is burnt away under an anæsthetic. The urethra itself must not be cauterized lest a stricture should follow.

Urethrocele.—A prolapse of mucous membrane occurs, and produces incontinence of urine, especially in little girls. The redundant mucous membrane is removed by the cautery.

Patent Urethra.—This is a congenital condition to which attention is drawn by incontinence. The urethra will admit the finger. It is reduced in calibre by the judicious use of the cautery. The urethra has also been dissected up and twisted through 180°, and there fixed by sutures.

Urethral Abscess and Sinus.—Purulent urethritis, generally of gonorrhœal origin, is treated by vaginal douches. When it persists, and pus can be pressed out of a sinus or pocket, the sinus must be slit up, scraped, and antisepticized.

Vaginal Abnormalities.

The Hymen.—The hymen when rigid forms a ring which resists both dilatation and rupture. It is notched, and forcibly dilated under an anæsthetic.

Tags of a torn hymen remain and cause pain and spasm (dyspareunia), and have to be removed by scissors and the cautery.

Hæmotokolpos.—An imperforate hymen is not usually discovered until after puberty, when the absence of the menstrual flux, in spite of the usual symptoms, brings about an examination. A fluctuating tumour is then found between the labia, and on rectal examination the vagina is found distended, sometimes, indeed, so much as to form an abdominal tumour.

Atresia of the Vagina — Hæmatometra — Hæmatosalpinx.—The lower part of the vagina may be occluded, whilst the uterus and tubes are felt per rectum to be much distended.

In evacuating the contents, especially when the uterus and tubes are involved, there must be a total absence of any pressure on the abdomen, for rupture may easily occur, or the fluid may be squeezed out through the fimbriated extremity of the tube into the peritoneal cavity. Moreover, septic infection of the contents is avoided. The patient is placed in the lithotomy position, and after being carefully cleaned a small incision is made into the tumour, and the thick, treacle-like fluid is allowed to escape slowly and of its own accord. When no more will flow, the hymen is fully incised, and the cavity washed out most gently with permanganate, whilst there must always be the fullest provision for a back-flow. A single strip of gauze is then inserted to act as a capillary drain, and an antiseptic dressing applied to the vulva.

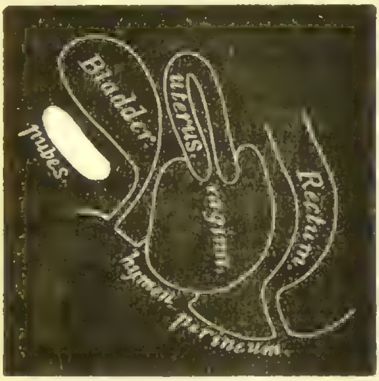

FIG. 93.—IMPERFORATE HYMEN: HÆMATOKOLPOS.

When there is atresia of the vagina, a sound is passed into the bladder and the finger into the rectum, whilst the line of the vagina is followed by the knife or scissors until the distended uterus is reached.

Acquired Vaginal Atresia or Stenosis is the result of syphilis, of injury during parturition, or of ulceration following the impaction of a foreign body. Careful dilatation is carried out with bougies and the fingers aided by notches with a knife until the cervix is reached. The vagina can then be plugged, or the dilatation kept up by bougies.

The labia of children adhere owing to superficial inflammation, but are easily separated by any blunt instrument.

Foreign Bodies in the Vagina.

Foreign bodies of all sorts are inserted into the vagina. Ulceration is set up with the discharge of pus and the formation of phosphatic concretions. Ultimately perforation into the bladder or rectum may take place, and a fistula form. A pessary remaining neglected in the vagina comes into this category. Removal may be difficult owing to the swelling or narrowness of the vagina and the phosphatic concretions. The foreign body has then to be broken up by a lithotrite or by bone forceps, so that it can be removed piecemeal. This process entails great care, lest the softened walls be perforated. When a fistula has formed, its cure is undertaken as soon as the vagina has returned to a healthy condition.

Laceration or Rupture of the Uterus and Vagina.

This may be due to attempts at procuring abortion, to rupture of the uterus during labour, or to rape.

The vagina being wiped out and illuminated, bleeding-points are tied, prolapsed intestines washed and returned, rents whilst still fresh sewn up, and the vagina dressed with iodoform gauze. The peritoneum may be involved, a fœtus or blood may have escaped into the cavity, or peritonitis may have already commenced. After a vaginal examination the abdomen is opened, the rent sutured, and the cavity washed out thoroughly.

A perforating wound is not necessarily fatal, either because intestine shuts off the general cavity, and so keeps the peritonitis local to the wound, or because the abdominal cavity is washed out early.

Vaginal Fistula.

This is generally a complication of protracted labour from pressure of the child's head. It may be due to the unskilful use of instruments during labour, or to criminal attempts at abortion. Vaginal lithotomy has left a vesico-vaginal fistula. Vaginal hysterectomy has caused one connecting the ureter with the vagina. A retained foreign body may also originate one.

Vesico-Vaginal Fistula.—The patient is placed in the lithotomy position, and the fistula exposed by a duckbill speculum and retractors. The edges are pared, then the mucous membrane of the bladder is raised, turned towards the cavity of the bladder, and sutured. The vaginal wall is drawn backwards towards the vagina and sutured. In this way raw surfaces are brought into contact. Fine silk sutures are inserted by curved needles on handles or in holders. The bladder is prevented from distending by the use of a rubber catheter.

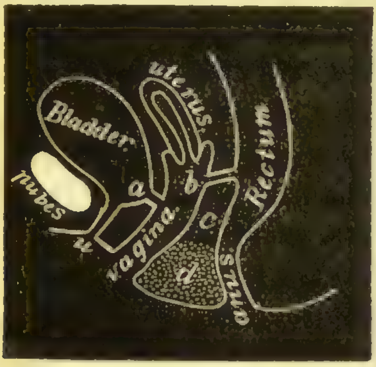

FIG. 94.—VAGINAL FISTULÆ. RUPTURED PERINEUM.

a, Vesico-vaginal fistula; *b*, recto-vesical fistula; *c*, recto-vaginal septum; *d*, perineum. The dotted area marks a complete rupture into the rectum.

Recto-Vaginal Fistula.—This is similarly treated. The mucous membrane of the rectum is turned towards the rectum and sutured, that of the vagina drawn forwards. No particle of mucous membrane should come into contact in the line of the wound, or union will fail at the spot.

Uretero-Vaginal Fistula.—This is situated high up by the cervix. The ureter is exposed above the fistula, resected, drawn down, inserted into the bladder, and fixed by sutures.

Suture of a Ruptured Perineum.

A rupture of the perineum can be imitated on the cadaver by incising the posterior fourchette, then the perineum along the median raphe, and so through the anus into the rectum.

Primary Suture, done immediately after the labour, is simply an exact union of this wound. The sutures of the perineum are inserted rather deeply. Those at the vaginal and rectal ends are superficial, but should be as exact as possible.

Secondary Suture.—When a ruptured perineum is not united at once by sutures, malunion occurs. It is illustrated on the cadaver by suturing the vaginal mucous membrane at the anterior end of the wound directly to the mucous membrane of the rectum at the hinder end along a transverse line, so that the sides of the perineal wound are kept widely apart. A woman in whom this malunion has occurred suffers from incontinence of fæces, or, when the anus is only weakened in part, flatus or fæces escape on any sudden strain.

The operation of secondary suture simply reverses the mode of occurrence. The bowels having been well cleared out and the vagina irrigated, the patient is placed in the lithotomy position, and the buttocks retracted. A transverse septum, the remaining portion of the recto-vaginal septum, has on its edge the line of union between the vaginal and rectal mucous membrane. At the sides, the junction with the skin of the vaginal mucous membrane in front of the septum and of the rectal mucous membrane behind is easily seen. It is this line of abnormal union which must be incised. The septum is split transversely by scissors or by a knife, and the incision is then carried forwards into the labia, and backwards to the side of the anus. Thus, the incision, when completed on both sides, has the form of the letter **H**. On the incision being deepened through scar tissue until it reaches the uninjured structures, the wound has become like that which existed immediately after the rupture. Deep sutures of silver wire are now passed through the sides of the perineum, the hindermost of which includes the muscular wall of the rectum, so as to draw down that tube; and the foremost does the same with the vagina. The deep sutures are tightened, and then superficial sutures of silk or fishing gut accurately unite the mucous membrane of the vagina and of the rectum.

No dressing is applied—merely iodoform powder. The patient's knees are tied together. The urine is drawn off with a catheter, generally in the lateral position, with the legs well flexed up. Constant attention is required by the nurse in order to keep the line of the wound clean and free from vaginal and rectal mucus. The bowels should be open on the third day, and then daily, the wound being dressed immediately afterwards. Opium should not be administered. By it the bowels are kept confined for a week or more; but meanwhile the patient feels uncomfortable, if not worse, flatus is often passing, and the scybala which form are likely to tear open the wound. The deep wire sutures are not removed until after three weeks. The patient may be warned to send for her medical attendant in any future labour long before there is danger to the perineum.

The Cervix Uteri.

The cervix is examined by the finger or through a speculum. In the course of operations, it is drawn down by a volsella or by a ligature passed through it.

The Suture of Fissures—Trachelorrhaphy.—Fissures with eversion of the edges occur in labour, especially when forceps are used. It is said that they are a source of pain, or are, on the other hand, causes of chronic inflammation and ulceration. Considerable doubt exists, and in consequence the indications for the operation are uncertain. The edges of the fissures are pared and brought together by sutures.

Hypertrophy of the Cervix.—The cervix may grow so much in length that, although the uterus remains in position, the os may extend to the lower opening of the vagina. It is then amputated either with scissors or by the ecraseur.

The Uterus.

The size of the uterus is first made out by bimanual palpation, the finger being passed both into the vagina and the rectum. At the same time, some general notion may be formed concerning the direction of the uterine cavity. The exploration by the rectum may be extended to the upper part of the uterus by fixing the cervix with a volsella, or by drawing the cervix downwards to the orifice of the vagina.

The Uterine Sound.—This is an instrument of limited value. By its use is learnt the length and direction of the uterine cavity, as well as the axis of the body as compared with the cervix. It may show, in addition to other methods, the size of the uterine cavity, the character of the endometrium—whether rough or smooth—and serves to distinguish a polypus of the inner wall presenting at the os uteri from an inverted fundus. The sound is made of flexible copper or silver, so that it can be bent in any direction. Its distal end is bulbous, in order to prevent perforation by gentle force; at 2½ inches from its point—*i.e.*, the normal length of the uterine cavity—there is a bend at an angle of about 160°. Its stem may be graduated to aid in marking the distance inserted. Before insertion the sound must be made aseptic either with carbolic acid or by passing through a flame. Instead of a metal instrument, in a case of any difficulty, a gum-elastic bougie is used. The sound is not used during the catamenia, or where there is pelvic inflammation or malignant disease of the uterus or suspected pregnancy, unless it be extra-uterine. The finger being placed on the anterior lip of the cervix, the sound is slid along the finger until it engages in the os, the handle describes a circle, and by minor movements, according to the direction, the sound slips in. No force must be employed. It is better in most cases to introduce a speculum in the dorsal position, and guide the sound or gum-elastic bougie with the eye. The distance inserted is fixed by the finger, or by putting on clamp forceps. The sound may carry in septic matter, and set up pelvic cellulitis or peritonitis;

it may perforate the uterine wall when softened during the puerperium or by malignant disease. It may induce abortion, or set up faintness when there is spasm of the internal os. It may enter a fallopian tube.

Dilatation of the Os Uteri.—Dilatation of the os is required in order to explore the interior and the condition of the uterine wall with the finger; in order to scrape away pus, sloughs, polypoid endometrium, or the remains of the fœtal membranes, as well as for the application of topical remedies; finally, as an aid in removing benign uterine growths, and for the completion of the diagnosis as to the existence of malignant disease of the fundus. Rapid dilatation can only be done without rupture when recent pregnancy has existed, or soon after abortion; otherwise slow partial dilatation must first take place. This is done by a tent which expands with moisture. The tent is passed through a speculum guided by the eye, the cervix being held. In twelve to twenty-four hours partial dilatation will have taken place, and this is increased by bougies or expanding dilators, so as to admit the finger. The exploration with the finger is combined with hypogastric pressure and palpation.

Curetting the Uterine Cavity.—This is especially serviceable for the removal of pus and placental débris when retained during the puerperium. It may also be employed for chronic purulent discharge with a polypoid condition of the mucous membrane.

When irrigating the uterine cavity, a free escape must be provided by means of a double-way cannula, lest fluid pass through the tubes into the peritoneum. Water is best, or the irrigation must finish with water, so that no antiseptic be left in. The uterus may be swabbed out with strong antiseptics, such as pure carbolic acid or linimentum iodi, all excess being washed away by irrigation with water.

A blunt curette is used, combined with irrigation. Pieces of fœtal membranes, pus, polypoid mucous membrane, or a new growth, may be removed. The vagina is afterwards filled with iodoform gauze. The uterus after delivery, when inflamed, is so friable that it can be easily perforated by a sound.

Uterine Hæmorrhage.—The vagina is plugged with gauze—iodoform gauze generally; but if this is too porous, carbolic acid gauze, or even lint; in the two latter cases iodoform powder is added. The plugging is done through a cylindrical speculum, which is gradually withdrawn. Failing a speculum, the index and middle finger of the one hand are inserted, and press on the posterior wall, whilst the strip is passed up in front of the fingers, and firmly packed round the cervix first of all. The plug must be withdrawn within twenty-four hours, and then a loose tampon of iodoform gauze can generally be substituted.

Mucous Polypi.—A mucous polypus generally grows from the cervix, and may protrude through the external os. It is simply clamped and twisted off.

If within the cavity, polypi are exposed only when the cervix is dilated, and may be numerous; the curette is used.

Submucous or Fibroid Polypi are fibro-myomata forming in the wall of the uterus, and protruding first into the uterine cavity, and later on through the os into the vagina. In the latter cases, a polypus is distinguished from an inversion of the uterus by the finger and probe, when it will be found that the probe can be passed into the cervix beside the neck of the tumour. If still in the uterine cavity, it is only exposed on dilating the cervix.

A fibroid polypus is drawn down, and its pedicle examined. If this does not appear vascular, the pedicle is snipped through with scissors; or the pedicle is clamped by long forceps, and cut away beyond the clamp, which can be allowed to stay on a day or so before removal.

Large sessile polypi are removed by cutting through their capsule and shelling them out, the capsule being separated by a raspatory or similar blunt instrument. When large, so that the base cannot be conveniently got at, the lower part of the tumour is drawn down and cut away piecemeal, bleeding-points being clamped until the base can be reached. The vagina is afterwards filled with gauze.

Displacements of the Uterus.

Displacements of the uterus are induced by habitual neglect to empty the bowels and bladder, by tight-lacing, by failure to rest after labour, by the strain of hard work, by a chronic cough. They are made worse by tumours or inflammations.

Retroflexion and Retroversion of the Uterus.—The uterus may be bent back on itself, or be rotated backwards as a whole. The fundus presses on the rectum, causing irritation, venous congestion, the discharge of mucus, and fæcal impaction. If the woman becomes pregnant, the uterus in enlarging may not rise out of the pelvis, but, remaining impacted, cause difficult micturition or retention of urine. A fibroid tumour of the uterus may do the same.

The uterus is replaced by the pressure of the finger, especially in the knee-elbow position, and if necessary under anæsthesia. Afterwards a pessary is placed in the vagina, the bowels kept open, and the bladder emptied every four hours.

Inversion of the Uterus.—When after labour the cord and placenta are drawn upon, the fundus of the uterus may follow, so that the uterus is turned inside out through the cervix. A raw bleeding mass is found in the vagina or between the labia, which is distinguished from a uterine polypus by the absence of a pedicle leading up into the cervix, and from a malignant growth of the cervix by the history of the onset and by the absence of the cervical canal. The inversion is restored by steady pressure upwards, with counter-pressure on the hypogastrium, and is kept from recurring by a pessary.

Prolapse of the Uterus.—The uterus descends, so that the cervix comes outside, or the whole organ may appear beyond the vulva.

It is accompanied by prolapse of the bladder, cystocele, or of the rectum, rectocele, which are dragged down with it. Rest with the buttocks raised, pessaries and aperients, are first tried. These measures failing, one of several operations may be performed.

1. *Anterior Colpotomy* and suture of the uterus to the anterior vaginal wall. Retroflexion may be overcome, and moderate cases of prolapse may be so far improved that a pessary will afterwards keep the uterus in place.

2. *Posterior Colpotomy.*—It especially allows of the separation of adhesions fixing the uterus back. After the adhesions are broken down, retroflexion may be overcome by a pessary.

The above operations are not likely to do harm. The following are only suitable for advanced cases where the patient cannot get about:

3. *Fixation of an Ovarian Pedicle.*—An ovary and tube are drawn out through an abdominal incision, ligatured and cut away, then the stump is fixed in the abdominal incision. This is certainly the operation when prolapse and an ovarian cyst occur together.

4. *Ventro-Fixation.*—This consists in pulling up the fundus of the uterus, and fixing it by deep sutures through the uterine and abdominal wall. There are two objections to this operation: its danger, deaths having occurred after it: and the position of the uterus when so fixed has seriously complicated pregnancy and delivery, and it appears therefore not suitable for a woman who may become pregnant.

5. *Shortening of the Round Ligaments* (Alexander's Operation).—The round ligaments are exposed on both sides by incisions over the external abdominal ring, but the aponeurosis should be kept intact. The round ligaments are sought within the ring by seizing the fibrous and fatty tissue with clamp forceps. They are freed from surrounding structures, drawn out until they become taut, yet without tearing them, and fixed to the aponeurosis of the external oblique. If the aponeurosis is not divided, there is no tendency afterwards to develop hernia. The operation cannot be used when the uterus is fixed by adhesions, *i.e.*, cannot be pushed up beforehand with the finger. Recurrence is avoided by careful suturing, and by keeping the patient in bed for a month afterwards.

Operations on the Uterus and Appendages through the Vagina.

It is a necessary preliminary that the course of the uterine arteries and the ureters should be well known.

If the cervix be drawn to one side so as to make the opposite lateral fornix tense, the pulsations of the uterine artery and branches may be felt between the thumb and finger. The smaller branches are below and run to the cervix; the main vessel reaches the uterus above the cervix. (Fig. 95, p. 484.)

The ureters run forwards at a distance of $\frac{1}{2}$ to $\frac{3}{5}$ inch from the side of the cervix, and reach the vaginal wall at the level of a line drawn transversely across the front of the cervix.

Anterior Colpotomy.—Anterior colpotomy, or incision of the anterior fornix of the vagina, is employed in order to fix in position a retroflexed or retroverted uterus. Through this incision the front of the uterus is examined, and after anteverting the fundus, the ovaries and tubes can be also explored, and any disease removed which is not very large or too adherent. The incision also forms part of vaginal hysterectomy.

A longitudinal incision is first made in the middle line from the cervix to the anterior vaginal wall, or it can be made transversely at the line of reflection of the mucous membrane. The bladder is pushed forwards by the finger or speculum, whilst the cervix is drawn down by a volsella. A sound in the bladder will aid in making out the fold of the peritoneum. The peritoneum is opened, the uterus anteverted by seizing the anterior surface above the cervix, and so the ovaries and tubes are drawn into the wound. In case of adhesions, these are broken down with the finger. In order to keep up anteversion, sutures are passed deeply into the anterior surface of the fundus, and then through the raw surface of the vaginal wall at the anterior end of the wound. Thus, when the sutures are drawn tight the raw surface of the uterus above the cervix is held anteverted against the raw surface of the anterior vaginal wall, between which firm union will take place.

Posterior Colpotomy.—Posterior colpotomy is required for opening abscesses following pelvic cellulitis, or for pelvic hæmatocele. It is also done in order to separate adhesions of ovaries and tubes by means of the finger, aided by the hand on the hypogastrium. Diseased ovaries and tubes may be examined and removed if necessary. This operation is especially useful whenever suppuration is present, as there is no danger of infecting the general peritoneal cavity, and drainage is good. The incision may be longitudinal or transverse behind the cervix, and on entering Douglas's pouch two fingers are inserted, whilst the other hand makes hypogastric pressure. For an abscess a small puncture is made, and forceps pushed onwards. A diseased ovary or tube is drawn downwards, ligatured, and cut away. The incision may be sutured at the sides, leaving an opening the size of the finger, or a drain may be inserted. The vagina is then filled with gauze.

Malignant Disease of the Uterus.

Cancer of the uterus begins in the vast majority of cases in the cervix. When it grows from the vaginal surface of the cervix, it is a squamous-celled epithelioma; when from the mucous membrane lining the cervical canal, the growth is a cylindrical-celled glandular carcinoma. These new growths assume one of two main forms—papillomatous, cauliflower-like, which has to be distinguished in its early stages from a simple polypus, and ulcerative, which in the earlier stages is difficult to differentiate from simple ulceration. The characteristic signs of malignant disease of the uterus are early and persistent hæmorrhage and fœtid watery discharge, and a progressively increasing nodular induration and ulceration. Pain is variable and altogether untrustworthy; it is frequently absent until the growth has extended beyond the cervix into the pelvis. Whenever there is doubt, a piece of the growth is snipped off and examined microscopically. The cancer tends to spread to the broad ligaments and to the wall of the vagina rather than to the body of the uterus, which therefore does not usually enlarge. Much more rarely malignant disease affects the body of the uterus. When the wall is mainly affected by sarcoma, the early sign is steady and progressive enlargement, but this is difficult to distinguish from fibromyoma. Occasionally malignant disease begins on the mucous surface as a soft rapidly growing carcinoma; then hæmorrhage and discharge may combine with enlargement, and the diagnosis be made by dilating the cervix and removing a portion of the growth for examination.

Cancer of the uterus can be cured by complete removal. Palliative measures consist in constant douches, destruction by the cautery of fungating masses, and the administration of opium.

The removal of the malignant disease by operation can only be of service when complete, hence an operation is only indicated when the uterus moves freely on palpation, when no induration of the broad ligaments is to be felt, nor any enlarged glands.

Vaginal Hysterectomy for Cancer.

When the disease is very early, and well confined to the vaginal surface of the cervix, a supravaginal amputation of the cervix is sufficient, and has cured many cases. But when the disease already involves the cervical canal, the exact limits of the growth are less clearly defined, and it is better to remove the whole uterus. When the patient has been placed in the lithotomy position, the vagina is cleaned out and retracted, and the cervix seized by a volsella. The cervix is pulled down to the vulva. If this cannot be done, some induration due to the new growth is likely to be present, and the operation is not only difficult, but of very doubtful value. The cervix having been pulled down, the peritoneum is opened through the anterior cervix, and the bladder and ureters pushed well forwards, and held there by retractors. Then Douglas's pouch is opened through the posterior fornix. The base of the broad ligaments on each side is next transfixed, and ligatured close to the cervix so as to avoid the ureters. Having divided on the distal side of these ligatures, the uterus is now further drawn down, bringing into view the tubes, ovaries, and finally the rest of the broad ligament containing the ovarian artery, which is similarly transfixed by a ligature, tied on each side, and then the uterus cut away. Instead of drawing the uterus straight down, it may be anteverted or retroverted after the ligature of the base of the broad ligament, if it is more convenient.

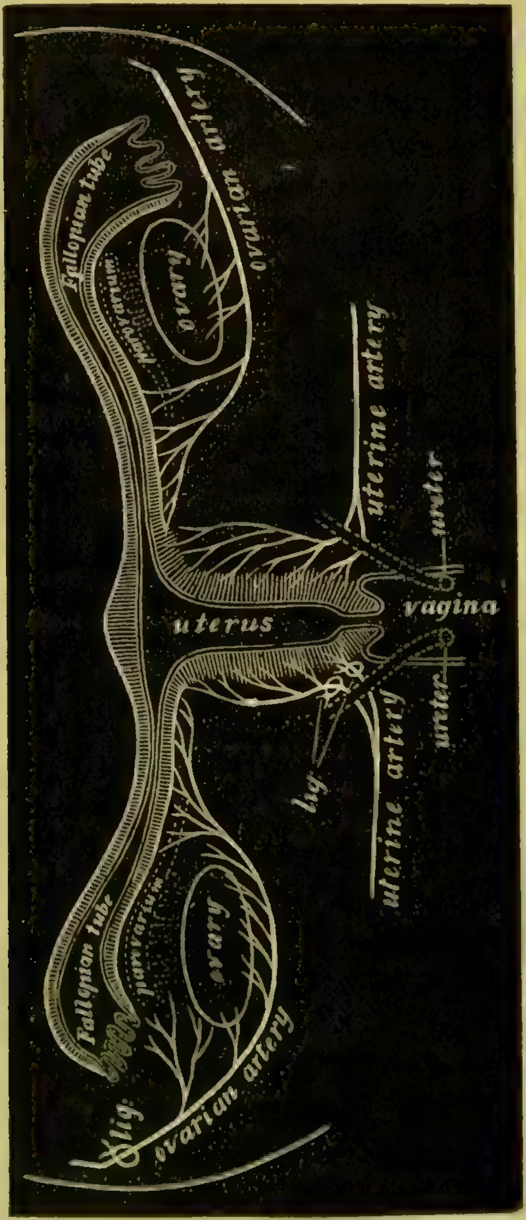

FIG. 95.—UTERUS AND ANNEXA.

Lig., the position of the ligature on the ovarian and uterine arteries respectively.

The ovaries and tubes are always removed if menstruation has not ceased. After the climacteric there is no need to do so; the upper ligatures can be placed at the junction of the tubes and uterus. One end of a strip of iodoform gauze may be inserted between the flaps, the rest of the strip being in the vagina, or, especially if the flaps curl towards the peritoneum, some sutures may be inserted on each side to draw them down. Some surgeons employ clamp forceps with long shanks instead of ligatures; the clamp forceps remain in the vagina, and are removed after a day or two, or are allowed to fall off. They are only of service when the uterus cannot be well drawn down, otherwise ligatures are much better. Supravaginal amputation of the cervix is begun in the same way as vaginal hysterectomy, except that the peritoneum is not opened. After a ligature has been placed on the base of the broad ligament on each side, the uterus is cut through at the junction between the cervix and fundus, but before doing so a stout silk ligature is passed through the stump, so that traction can be made, and any bleeding-points are then easily clamped and tied.

Removal of One or Both Ovaries—Oöphorectomy.

The removal of both healthy ovaries is very rarely indicated, for when undertaken before the climacteric, it not only renders the woman sterile, but causes alterations in the sexual feelings. Likewise it is apt to set up nervous disorders, rendering the patient beside herself, and leading her to hate the surgeon. The operation may, however, be done in the endeavour to check constant and severe hæmorrhage from a fibromyoma. An artificial climacteric, followed by shrinkage of the tumour, is hoped for, and the operation is not so dangerous as hysterectomy. Double oöphorectomy is indicated for osteo-malacia, occurring in young women, generally in connection with pregnancy. After it the bones become firm again, and the woman can soon walk.

The removal of one ovary may be required, because it is persistently painful, especially during menstruation. The ovary may be in its normal position, or prolapsed into Douglas's pouch, or into a hernial sac.

Palliative measures are first tried, such as rest, aperients, douches, pessary, and separation from the husband. If these fail, the ovary can be explored through the vagina or after an abdominal incision. If small cysts or an abscess be found, incision and scraping are done, or part of the ovary is excised, and the rest sutured together. When, however, the ovary is completely fibrous or cystic, it is removed. An ovary merely prolapsed may be sutured in position to the abdominal wall.

Ovariotomy for Ovarian Tumours.

Solid tumours are rare as compared with the cystic ones. Solid tumours are benign, fibrous, or malignant, sarcomatous and carcinomatous. They are generally pedunculated, but the malignant ones soon extend to the pelvic tissues and glands as well as to the peritoneum.

Cystic Tumours.

The common ovarian tumour is a multilocular cyst, one cavity being by far the largest, and there is a variable though small amount of glandular matter between. It contains an albuminous glairy fluid, or thick colloid or jelly-like material. It forms in the projecting true ovary by cystic degeneration of some of the cells which have to do with the formation of the ovum. It is well pedunculated, and is not liable to malignant disease. The other forms are less common.

The dermoid cyst contains hair and sebaceous material excreted by true skin lining the cyst wall, occasionally also bones, teeth, etc. They are generally pedunculated, and often bilateral. But the chief point about them is their tendency to early malignancy.

Papilliferous cysts grow from the remains of the Wolffian body, the parovarium. The cysts contain a thin non-albuminous fluid, and are characterized by papillomatous, wartlike intracystic growths. The cysts tend to be sessile, having the tube and ovary spread out on their surface. The papillary masses may form secondary cysts, burrowing in the layers of the broad ligament. Papillomatous masses may fungate on the surface and cover the broad ligament, tube and ovary with growths, and excite peritoneal exudation by extension. A favourable result follows the complete removal. On the other hand, masses which are left behind continue to grow.

The unilocular cyst of the broad ligament contains only watery non-albuminous fluid without papillary growth. It is commonly called a 'parovarian' cyst, although its origin is still uncertain. It is usually pedunculated, and has the tube and ovary spread out over it. It is excised either by ligaturing its pedicle or by shelling it out from its capsule. The ovary and tube may be separated and preserved if healthy and the woman young, especially when the cysts are bilateral.

Diagnosis of Ovarian Cysts.—It is important to exclude those conditions for which it would be a mistake to open the abdomen. Between diseases which in any case require to be treated by abdominal incision, there is no such need of differentiation; indeed, it is impossible to diagnose with certainty except in the cases of the typical multilocular cyst. The conditions which must first be excluded are:

(*a*) Distension of normal cavities, the bladder with urine, the intestine and rectum with fæces, the uterus and vagina with menstrual blood, the gall-bladder with bile.

(*b*) Pregnancy in all its forms except extra-uterine fœtation must be excluded. This is most difficult when the fœtus can neither be heard nor felt owing to hydramnios.

(*c*) Simple ascites from cirrhosis of the liver, portal obstruction, etc., may be proved by tapping. Ascites secondary to malignant disease, or when encysted owing to tuberculosis, are conditions difficult to distinguish, but in such cases an incision will do no harm—indeed, the contrary.

(*d*) Phantom or false tumours are formed by flatus, fat in the abdominal walls, or by spasm of the muscles. A bimanual examination shows the non-existence of a tumour, and this is confirmed upon the administration of an anæsthetic.

An ovarian cyst distends the abdomen prominently in front, and not also in the flanks, as does free fluid. Whilst dull to percussion in front, in the flanks and above the umbilicus there is resonance, the tumour moving up and down with respiration, unless very big or fixed. As distinguished from a fibromyoma of the uterus, an ovarian tumour is nearly always cystic, a uterine tumour nearly always solid. A uterine fibroid is generally accompanied by menorrhagia and by a lengthening of the uterine cavity, both of which are absent in the case of ovarian cysts. In the case of an ovarian cyst the cervix is normal in position, and usually nothing particular can be felt in the pelvis except the cystic swelling; a uterine tumour tends to draw the cervix up. Hæmatocele from extra-uterine fœtation has a sudden onset, and forms a fixed pelvic mass; an ovarian tumour grows without incidents in the early stages, and is freely movable, except in the advanced stages of cancer.

Pelvic peritonitis, cellulitis, and pyonephrosis are inflammatory, generally of puerperal or gonorrhœal origin, although occasionally tubercular. Except in very advanced cases, œdema of the limb, distension of superficial veins, and rapid loss of flesh, point to malignant disease as distinguished from the typical ovarian cyst. The spleen and kidney, or even the liver, may be displaced towards the pelvis, and such tumours may come to fill much of the abdomen. In the early stages it can be seen that the pelvis and pelvic organs are free, whilst the tumour can be easily returned to its position when the patient lies down. A kidney tumour should occupy the loin, and not move with respiration, but neither of these conditions holds when the tumour has been displaced. In later stages all that can be said is that the tumour is not a typical ovarian cyst. In such cases, and also in the case of hydatid, mesenteric or pancreatic cysts, the diagnosis cannot be made with certainty before the abdomen is explored.

Ovariotomy.

The principles of abdominal surgery, of which details have been given, apply. After making an incision of about 3 to 4 inches, a bluish-gray fluctuating swelling is exposed, with scarcely any free peritoneal fluid. The finger is swept round the immediate neighbourhood of the wound in search of adhesions, omentum, or coils of intestines. Next the wound is retracted, packed round with sponges, and a trocar and cannula plunged into the cyst. As the fluid escapes on withdrawing the trocar, the cyst wall is seized with forceps and drawn forwards. The emptying of the main cyst may allow the rest to be delivered, or another cyst may require to be punctured through the wall of the main one. The sponges prevent fluid which escapes beside the cannula from getting into the abdomen, and the smaller and deeper the cyst, the more care required in protecting the rest of the cavity. When the whole cyst has been drawn out, its pedicle is found to consist of the broad ligament, with the tube on one side and the ovarian vessels on the other. An interlocking pedicle ligature is tied tightly, so as to include the tube and vessels below the cyst. Around this a circular ligature is tied as a further safeguard. The cyst is then cut away, leaving a good frill beyond the ligatures, which is clipped by forceps, so that the pedicle can be drawn up into view at any time, whilst the ligatures are cut short so as to avoid pulling them off accidentally. In a simple case the surgeon should have prevented any soiling of the peritoneal cavity. He has then merely to inspect the opposite ovary to see whether it is normal, to wipe out blood from Douglas's pouch, to remove the sponges—which are duly counted—and to have a last look at the ligatured pedicle before taking off the forceps clipping it.

When the cyst contains thick colloid fluid, which will not run through the cannula, the cyst is incised and the contents scooped out with the hands until the tumour has been sufficiently reduced to be drawn out. If the tumour is semi-solid, the wound must be enlarged upwards to or beyond the umbilicus.

Adhesions with the omentum at the upper part are common. The omentum is tied by a pedicle ligature and cut away. Adhesions to the abdominal wall, and to the wall of the pelvis, and of Douglas's pouch, are gradually and carefully separated by the hand and fingers. Adhesions to the intestines are dissected off, and a piece of the cyst wall should be left so as not to cut or tear the gut. The piece so left may afterwards be shaved off, and the raw surface drawn together by sutures. Adhesions to the uterus are treated in the same way, and the drawing of the raw surface together by sutures is sufficient to arrest the hæmorrhage. Bleeding from parietal adhesions is stopped by pressure with hot sponges, by ligature, by transfixing the bleeding-point with a suture and tying over it, or by plugging with a strip of gauze, the end of which is brought out of the lower end of the wound. This last method has superseded the actual cautery and the application of styptics. When the pedicle is very short, the cyst has to be partly shelled out from the broad ligament before the ligature is applied, the chief attention being directed to securing the ovarian artery, before it is torn across and retracts, at the point where it enters the broad ligament from the side.

Papilliferous cysts grow in the broad ligament, separate its layers, and often burrow deeply. The broad ligament forming the capsule is divided, the ovarian vessels sought for and tied, and then the rest of the cyst enucleated. The material ought not to escape into the peritoneal cavity. When the cysts have already burst into the peritoneal cavity, all portions must be removed by thorough irrigation with hot water. Drainage either by a glass tube or a strip of gauze is generally required.

The Second Ovary.—Whenever the woman is near the climacteric, the ovary on the opposite is always removed if it shows any sign of disease.

In a young woman, the other ovary is only removed when it is evident that by leaving it another operation would shortly be necessary. Parovarian cysts are excised, leaving the ovary intact. If the second ovary shows two or three small cysts on its surface, these are incised, and the contents scraped and wiped out, the rest of the organ being left.

Inflammatory Complications of an Ovarian Cyst.

When the pedicle undergoes torsion, symptoms of intestinal obstruction arise, whilst inflammation, sloughing, and local or general peritonitis follow. Suppuration of an ovarian cyst, due to septic infection, is treated by first shutting off the peritoneal cavity, unless adhesions have already formed, by stitching the cyst wall to the parietal peritoneum. The contents are then evacuated, the cavity wiped out with 5 per cent. carbolic acid, and filled with iodoform gauze, the ends of which hang out of the wound ; or the cavity may be simply drained.

When an ovarian cyst has suppurated and burst, so that the general peritoneal cavity is infected, as much of the sloughing cyst wall is cut away as possible, but without separating any adhesions. The whole of the peritoneal cavity is washed and wiped out and closed, with a drain passed into Douglas's pouch.

Malignant Disease of the Ovary.

Malignant disease still confined to the ovary is removed if a fair pedicle can be obtained, but the operation is only a palliative one in the majority of instances.

Irremovable malignant disease should be recognised immediately on opening the abdomen, for the attempt to partly remove a malignant growth leads to the tearing of friable cancerous tissue, profuse and uncontrollable hæmorrhage, and the premature death of the patient. Irremovable malignant disease is recognised by the excess of dark-coloured peritoneal fluid, by nodular masses scattered in the peritoneal lining or in the omentum, also by enlarged glands behind the peritoneum, continuous with a thick mass in the broad ligaments. On finding such conditions, nothing more should be done beyond inserting a drainage-tube. An exception may be made where a fungating mass projects into the peritoneum with a good pedicle, for by its removal the peritonitis and formation of fluid may be lessened.

The only benign condition likely to be mistaken for malignant disease is that above described of papillomatous cysts, which have on the one hand burrowed deeply into the broad ligament, and on the other hand have ruptured into the peritoneal cavity, so that the peritoneal surface has on it soft papillary growths.

Fallopian Tubes.

The tubes may be distended with mucus, the result of a kink, or with pus from gonorrhœal or puerperal inflammation, or from tubercular disease. One or both tubes enlarge and tend to form sausage-like masses behind and to the sides of the uterus, which are to be felt through the vagina, and especially through the rectum. The distended tubes may be operated upon either through the abdomen or through the vagina. A diseased tube is excised after ligaturing the broad ligament. The ovary is preserved if not diseased, and the junction of the tube with the uterus is left freely open in the case of a mucocele, but ligatured when there is pus in the tube or in the uterus. The peritoneal cavity is protected, but if a tube has ruptured all the pus is cleared out and the pelvis drained.

Pelvic Peritonitis.

At any stage pus may escape from the fimbriated extremity of the tube, and set up general peritonitis or merely a localized pelvic abscess. The abscess may point in Douglas's pouch, and burst into the bladder or the rectum. It may be felt above Poupart's ligament, or, rising up behind the anterior abdominal wall, it may burst at the umbilicus.

When an abscess has formed, it is best opened through Douglas's pouch. When, however, the purulent peritonitis becomes general, whether from primary rupture of a tube or escape from the ostium, or when secondary by the giving way of adhesions confining it to the pelvis, the abdomen must be opened.

Pelvic Cellulitis.

A parametric abscess follows septic cellulitis, puerperal or gonorrhœal in origin, or is due to the secondary decomposition of a pelvic hæmotocele, produced by the bursting of a tubal pregnancy into the broad ligament. It tends to point in the vaginal vault, where it may be best incised. If neglected, it may rise up and point in the groin, or even as high as the umbilicus in front of the peritoneum, or burst into the bladder or rectum, but not into the peritoneal cavity.

Extra-uterine Fœtation.

In nearly all cases extra-uterine fœtation commences by a development of the fœtus within the Fallopian tube. The cause of the arrest in the descent of the ovum is unknown; previous disease of the tube has not been demonstrated to be a general antecedent. The tube is incapable of stretching very much, and soon gives way. This it usually does into the layers of the broad ligament, within which the fœtus continues to develop. The pregnancy may go on to term in this position with the child still alive. The fœtus may die, mummify, and the mummy later on become calcified. The mummification may be interrupted by suppuration; the fœtus then macerates in the abscess, and pus and bones are discharged into the vagina or rectum, or at the umbilicus. At any time blood may escape from the fimbriated extremity of the Fallopian tube, and form a hæmatocele; or a rupture may take place, when there is not only an escape of blood into the peritoneum, but acute anæmia from a continuation of the bleeding.

The most definite indication for surgical interference in the case of extra-uterine fœtation is for rupture. A woman likely to be pregnant, who has missed or has had only irregular periods, and who presents other signs of being about three months pregnant, is suddenly seized with abdominal pain, and becomes faint and pale. She is found with a feeble pulse, and has the signs of free fluid in the abdominal cavity and in Douglas's pouch. She may become unconscious, pulseless, and the respiration shows signs of failing, becoming sighing and gasping. It is necessary to arrest the bleeding at once. On opening the peritoneal cavity, the hand is at once thrust in, and seizes the broad ligament and ovarian artery, which is bleeding, upon which a clamp is placed. When once the vessel is secured, 2 pints of hot water may be injected into the rectum, or, in a very severe case, 4 to 6 pints of salt solution are infused into the basilic vein. All blood is then wiped out of the peritoneal cavity, the broad ligament—including the ovarian artery—is ligatured, and the mass forming the extra-uterine fœtation excised.

A hæmatocele is treated by rest and purges, but is not operated upon unless suppuration threatens, when it is opened through the posterior vaginal fornix. When there has been no previous septic inflammation of the genital tract, the suppuration is presumably caused by nearness of a coil of intestine. Before the fifth month of pregnancy, pain may draw attention to a growing pelvic tumour distinct from the uterus, and which, after removal, is found to contain a fœtus or chorionic villi. After the fifth month extra-uterine fœtation is difficult to diagnose—*e.g.*, from pregnancy in a uterine cornu. If the pregnancy goes on to term, the child may be possibly delivered alive without any further danger to the mother. Tait's operation consists in opening the abdomen 2 to 3 inches from the middle line, so as not to enter the general peritoneal cavity, removing the fœtus, and ligaturing the cord close to the placenta. The amniotic cavity is washed out and closed, after which the placenta may atrophy and disappear.

When the child is dead and suppuration has taken place, the sac is opened through the vagina, or by an abdominal incision outside the peritoneum, the contents, including the placenta, removed, and the cavity washed out and drained.

The chief danger lies in removing the fully formed placenta whilst still vascular, on account of the uncontrollable hæmorrhage from the sinuses of the sac wall, which has not the spontaneous contractility of the uterus. After the death of the child the vessels shrink, and the placenta can be removed with impunity. Indeed, when suppuration occurs, it becomes a slough in the sac.

Uterine Fibrous Tumours.

These tumours are of three kinds. One or several tumours protrude on the surface of the uterus into the peritoneal cavity, and may be felt bimanually.

The second kind is a general enlargement of the body of the uterus without any sharply defined tumour.

The fibroid in the third form protrudes into the cavity of the uterus, and passes through the cervix into the vagina.

The first necessity in the case of a uterine tumour is to exclude pregnancy. This being done, the indications for operation are of two kinds: one the size of the tumour, the other hæmorrhage.

The size of the tumour may be chiefly marked by the abdominal protuberance. This early becomes intolerable in a young single woman. It may be put up with even if very large in a married woman approaching the climacteric, for then it may be hoped that the tumour will shrink. A tumour which has been for years stationary may take to growing. When this happens, especially after the climacteric, suspicions of malignancy may arise, and indicate an operation. On abdominal section, a well-pedunculated tumour may be excised after ligaturing the pedicle; sessile tumours may be shelled out and the capsule united by sutures. When the enlargement affects the whole of the body, hysterectomy is required.

For persistent menorrhagia the cervix may be dilated, and any fibroid polypus cut or scraped away; the fundus is then packed to arrest hæmorrhage. If there is continuous and severe hæmorrhage without any very marked tumour, double oöphorectomy may be done, or ligature in continuity of the uterine arteries in the base of the broad ligament through the vagina.

Abdominal Hysterectomy.

The vagina must be carefully syringed and sponged out for some days beforehand, and finally packed with gauze. An incision long enough to allow the tumour to be delivered is made. The broad ligament is ligatured and cut through outside the ovary on both sides. A transverse incision is next made in front, and the bladder and ureters carefully pushed forwards by keeping close to the uterus until the anterior vaginal fornix is reached; then the posterior fornix is opened in the same way. The sides containing the uterine artery are each transfixed and ligatured off close to the uterus, special care being taken in cutting away the uterus to leave a piece on the distal side of the ligature, which cannot then slip off.

Instead of a ligature, long clamp forceps may be applied by being pushed up through the vagina. Sometimes it is easier to ligature the uterine arteries from the vagina after opening the anterior and posterior fornices. If so the ovarian arteries in the upper part of the broad ligaments are tied; then the neck of the tumour is surrounded with a tight band, and the main tumour cut away, after which the operation can be completed from the vagina. Finally the peritoneum is brought together by a transverse suture running across the pelvis, so leaving the ligatures in the vagina, which is packed with iodoform gauze.

Instead of removing the whole of the uterus, the cervix may be left and treated by the intraperitoneal or by the extraperitoneal method, but there is always more liability to recurrent hæmorrhage.

Intraperitoneal Method.—A flap of peritoneum is turned down from the tumour in front, and the ureters and bladder pushed forwards. A posterior flap is also turned down, but in neither case is the vaginal fornix opened. The broad ligaments are tied, and the tumour being now outside the abdomen, the neck, after being surrounded by sponges, is slowly snipped across with scissors; spouting vessels are caught and afterwards tied. When all bleeding has been stopped by ligature or pressure, the cavity of the cervix is treated either by the cautery or by pure carbolic acid on a glass rod, so as to render the cavity antiseptic, and the cervical canal is closed with sutures, and then the flaps of peritoneum are sutured over the stump. The vagina is filled, as before, with gauze. The danger in this method is from recurrent hæmorrhage from the stump. An elastic ligature may be used whilst cutting away the tumour, and the uterine arteries tied before the ligature is slackened.

Extraperitoneal Method.—The broad ligaments are ligatured off, the tumour delivered, and the abdominal wound brought into contact round the neck, so as to shut off any further communication with the peritoneal cavity. A wire ecraseur is now applied tight enough to constrict the neck without cutting, and the tumour is removed beyond. The peritoneum may be sutured round the neck on the *proximal* side of the ecraseur, and two pins passed through on the *distal* side of the wire. The ends of the pins rest on the abdominal wall, and so support the stump. The stump is dressed with iodoform. The ecraseur is tightened very gradually as the tissues shrink, just enough to control hæmorrhage, but without cutting through until the pins and wire come away with the slough. The stump then sinks back, and leaves an ulcerating channel, which slowly heals. The advantages of this method are the control of hæmorrhage from a vascular stump and the rapidity of the operation. The objections are the drawing on the bladder, causing irritation, the slow healing of the abdominal wound after the separation of the stump, on an average about six weeks, and the difficulty of tightening so as to arrest hæmorrhage without cutting through too rapidly.

A method suitable for subperitoneal tumours is to suture the peritoneum round the stump, then to enucleate or to cut away the tumour with scissors by small snips, arresting hæmorrhage at each step. The muscle and skin are united over the stump, which now lies, therefore, outside the peritoneum.

Operations for the Delivery of a Living Child in the Case of Difficult Labour.

Division of the Symphysis Pubis.—After rendering the skin over the pubes antiseptic by washing and shaving, a bistoury is passed down behind the symphysis through an incision, and the cartilage of the symphysis divided. On pressure upon the iliac spines, the symphysis should separate, so that the child can be turned and extracted. The wound must be carefully closed by suture. The urethra may be injured.

Cæsarean Section.—By an incision in the middle line the wall of the uterus is met with in front of the peritoneum, which has been pushed up. The wall is cut into and the wound enlarged by inserting and separating the fingers. The child is rapidly extracted, and then the placenta. The uterus is strongly squeezed to make it contract, and sutures are inserted through the muscular wall, without penetrating the uterine cavity. The uterus being well contracted and all clots squeezed out of it, the abdominal wound is sewn up. If the peritoneal cavity is opened, it is guarded with sponges. After applying the abdominal dressing the vagina is cleared out, and a light dressing of gauze inserted.

Expedients for preventing future pregnancies are outside the duty of the surgeon. Cæsarean sections have been repeated with complete success as regards both mother and child. Therefore removal of ovaries, resections or ligatures of the tubes, or removal of the uterus, are not to be done when these organs are healthy. But the patient is informed of the risk she runs in future pregnancies.

CHAPTER XXXVII.

SURGERY OF THE SHOULDER AND ARM.

The Clavicle.

Fracture.—In nearly all cases the fracture occurs in the middle of the shaft; the majority of these are in children under five, in whom the fracture is incomplete, a greenstick fracture. Those which occur in adults require great attention, or deformity will ensue. The exceptional cases of compound fracture from direct causes are dangerous either from septic infection or on account of simultaneous injury to neighbouring structures.

The fracture is generally due to indirect violence from falls on the hand, forearm, elbow, or shoulder. The force acts upon the bone, firstly, by driving the acromial towards the sternal end, causing the shaft to yield where weakest—viz., at the junction of the two curves, which gives the bone its **S**-like shape—and, secondly, by forcing the outer end downwards and backwards, so that the bone is broken across where it presses on the fixed first rib. Direct violence, a fall, or a bullet wound, may cause a compound fracture at any point of the bone. Although not compound, the subclavian vein or artery may be ruptured, the brachial plexus torn, the first rib fractured, and the pleura or lung lacerated.

Muscular force employed in lifting weights, throwing stones, flogging, etc., in which a twist is given to the arm whilst extended, has caused a fracture, due to the violent contraction of the deltoid and clavicular attachment of the pectoralis major, aided by undue fragility of the bone.

In children—especially when rickety—the **S** curve is simply exaggerated so that the inner portion shows an excessive anterior curve, and the outer half curves backwards more than usual. Or there may be a sharp angle at the site of the incomplete fracture.

The typical displacement is generally seen in adults. The displacement belongs entirely to the outer fragment; the inner fragment does not move, the rhomboid ligament counteracting the sterno-mastoid muscle. The outer fragment sinks downwards owing to the weight of the arm, and is pulled down by the latissimus dorsi, the trapezius being unable to resist. The pectoralis major and minor pull the outer fragment inwards, and, with the serratus magnus, rotate the acromial end of the outer fragment forwards. The result is that at the site of fracture the outer end of the inner fragment projects beneath the skin, owing to the falling of the shoulder, and the inner end of the outer fragment is pushed behind and above it in consequence of the displacement downwards, inwards, and forwards of the acromial end. The shortening of ¼ to ¾ inch between the

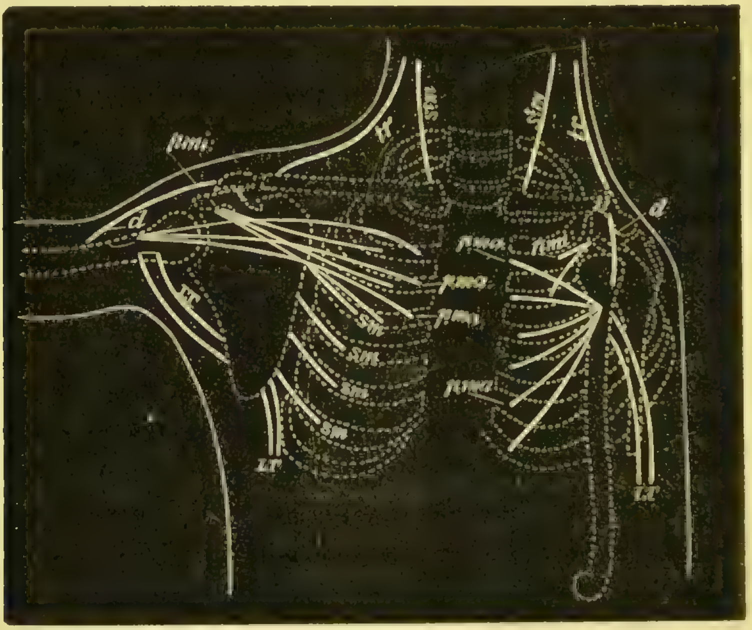

FIG. 96.—FRACTURE OF THE CLAVICLE.

On the left side is shown the displacement due to muscular action. *st m*, Sterno-mastoid muscle; *tr*, trapezius; *d*, deltoid; *p ma*, pectoralis major; *p mi*, pectoralis minor; *L T*, latissimus dorsi; *s m*, serratus magnus.

ends of the bone will depend on the amount of displacement. The fracture is reduced by putting the knee between the scapulæ whilst the patient is sitting, and drawing the shoulders strongly backwards. The simplest way of maintaining this reduction is to keep the patient flat on the back on a hard bed, with a small pillow between the shoulders, for three weeks. This should be adopted in all cases where the reduction is not well kept up, for a small deformity weakens the arm, especially for overhead action, and the projecting bone is irritated by the clothes and braces. The deformity shows when a woman wears low dress. Moreover, the strapping and bandages cannot be so firmly applied to a woman on account of the breasts and thoracic breathing. Treatment in bed is, of course, necessary where surrounding structures have been injured, or where the fracture is compound.

In the case of men who cannot or will not stay in bed, the clavicle is fixed by Sayre's method. A piece of strapping 2 inches in breadth and in length nearly twice the circumference of the chest is taken, and one end sewn round the arm on the fractured side just below the deltoid prominence, the sticky side of the strapping being towards the thorax. The free end of the strapping is carried across the back and round the chest in front to the back again, the arm being drawn back as strongly as possible. Another similar piece of strapping draws the elbow on the affected side forwards and inwards by fixing the strapping first on the sound shoulder, then across the back and elbow, over the chest to the sound shoulder again ; the strapping is then covered by a bandage, and the elbow supported by a sling. By this plan the head of the humerus and the acromial end of the clavicle are held back and up by the fixation of the upper third of the humerus and the pulling forwards of the elbow.

If, after the application of the strapping, the reduction is maintained, there may be no relapse, supposing good strapping of sufficient length to have been used. Still, as in all cases of fracture, the patient should be seen daily for the first week.

Children are often brought long after the fracture ; if seen early, the bent bone may be straightened by the thumb and finger, and the arm loosely bandaged to the side. If the fracture is already fixed, free use is encouraged.

A transverse fracture may occur without displacement, and union readily takes place, although the arm is simply kept in a sling. This lack of displacement is also seen in the fracture of the outer end of the bone, owing to the fragments being held by the conoid and trapezoid coraco-clavicular ligaments, and in fracture of the inner end, by the rhomboid costo-clavicular ligament.

Delayed union or non-union, whether from necrosis or from lack of rest, need not be followed by any great loss of muscular power. If this, however, does result, secondary resection and wiring will be indicated.

Complications of Severe Fractures of the Clavicle.—The brachial plexus may be lacerated or secondarily irritated by the unreduced fragment, or be involved by the callus. Hence pain, paralysis of motion and sensation, wasting and contracture, will result. The bone is resected, and the movements of the arm restored, aided by massage.

An excessive pad in the axilla (there is no need for one at all), over which the arm was tightly bandaged, has caused a similar condition, the axillary nerves being compressed.

A traumatic diffuse aneurysm of the subclavian artery may end fatally. The subclavian and even the internal jugular vein have been ruptured, and death has followed the admission of air. The first rib has been fractured. Also the lung may be ruptured, and give rise to emphysema and pneumothorax.

Sterno-Clavicular Dislocation.—It is most commonly forwards, from a blow on the front and outer part of the shoulder, which, by rotating the shoulder backwards, drives the sternal end forwards and inwards. It may also be produced by muscular force, the shoulders being thrown violently backwards in gymnastic exercises, in swimming, or during parturition. The head of the bone is seen and felt resting on the front of the sternum, the rhomboid and capsular ligaments having been torn through, unless in the former case the cartilage of the first rib yields instead. The joint may be a loose one, and subluxation then occurs without rupturing ligaments. In some people the sterno-clavicular joint is very shallow, and the head of the bone projects unusually; but then the condition will be found on both sides.

The treatment is the same as for fractured clavicle. It is a dislocation easy enough to reduce, but difficult to keep in position. The recumbent method is then the one to use.

Less often the dislocation is backwards, upwards, and inwards. The head of the bone comes to lie behind the manubrium in the jugular fossa, or above as high up as the cricoid cartilage. This kind of dislocation is due to direct violence from in front, such as the kick of a horse. The bone may be pushed between the insertions of the sterno-mastoid, or rupture this muscle, and also the sterno-thyroid and sterno-hyoid. It may be impossible to reduce the dislocation by drawing back the shoulders, and an incision is then necessary, and the end of the bone cut off if it presses upon the trachea or œsophagus.

Acromio-Clavicular Dislocations.—Strictly speaking, these dislocations are dislocations of the scapula and its acromion process from the clavicle, which remains *in situ*, and they are described under the scapula. But many surgeons speak of the clavicle being dislocated; then, of course, the words "upwards" and "downwards" have the reverse meaning to that which they have when applied to the scapula.

Disease of the Clavicle.—The sterno-clavicular joint may be affected by tuberculosis; pus may form in it in the course of pyæmia. Rheumatoid arthritis and locomotor ataxia also attack it.

Acute periostitis may occur primarily in the shaft of the bone, or spread secondarily to it from the shoulder or sterno-clavicular joints. An early incision must be made, or necrosis will follow, and the sequestrum have to be removed.

Necrosis occurs as above, or following a compound comminuted fracture. The periosteum, when not destroyed, readily forms new bone.

Tumours of the Clavicle.—A tumour growing from the periosteum, and surrounding the bone rapidly, is either of syphilitic origin or a sarcoma. The former having been excluded by internal treatment, the prognosis becomes grave. An exploratory incision may be made to confirm the diagnosis, but it is useless to attempt removal if no capsule is found. The surrounding structures will be already infiltrated.

A myeloid sarcoma grows slowly from the centre of the shaft, and until late is enclosed in a shell, and does not infiltrate the tissues around. It may be successfully removed.

One of the most brilliant operations ever done was the removal by the American surgeon Valentine Mott, in 1828, of a central sarcoma of the clavicle 4 inches in diameter, which had already involved the skin. The operation was done without anæsthetics, without antiseptics, and without such clamp forceps as are now used, on a man of nineteen. It lasted four hours, and forty ligatures were employed to restrain the hæmorrhage. The subclavian vein, the thoracic duct, and the phrenic nerve were exposed, but the patient recovered, and lived until 1883, dying when seventy-three. Many such tumours have since then been successfully removed, and a cure can be confidently anticipated if the tumour is encapsuled. Exostoses and enchondromas have also been removed.

The Scapula.

Fractures of the Blade-bone are uncommon, owing to its being embedded in muscles. Severe direct violence, such as blows, kicks, and falls, either knock off the lower angle or cause a starred fracture which may run through the spine from the infraspinatus to the supraspinatus fossa. There is no displacement, only crepitus and increased mobility. A shield of guttapercha may be made, bandaged on, and the arm kept in a sling.

Fracture through the Surgical Neck is caused by severe violence, such as a heavy fall on the shoulder. The head of the humerus and the glenoid cavity fall into the axilla, in this way resembling a subcoracoid dislocation. But the fracture of the neck differs from a dislocation in being easily replaced by pushing up the elbow, and as easily recurring when the pressure upwards is taken off. There is also obtained crepitus, and the coracoid process moves with the head of the humerus, and not, as in a dislocation, with the rest of the scapula. The accident may be complicated by fracture of the upper end of the humerus, laceration of nerves, or rupture of the axillary artery. The arm and shoulder must be fixed as for fractured clavicle, and the patient should be kept flat on his back until the union has occurred. If primary union fails, the fragments may have to be fixed in position by wire.

Fracture of the Acromion Process.—Opinions have differed much as to frequency. It is generally held to be rare; museum specimens have been suspected of being instances of cartilaginous union dissolved by boiling, and dissecting-room specimens of fibrous union to be specimens of incomplete epiphyseal ossification, *i.e.*, a congenitally separate acromion process. Irregularities about the junction of the clavicle and acromion must be compared with the uninjured side, and if found also to exist there a hasty diagnosis of fracture will be avoided. An acromion process may be disunited in the course of rheumatic arthritis. Only when marked crepitus and increased mobility follow immediately upon an injury can a fracture be diagnosed. Before twenty-five the condition will probably be a separation of an epiphyseal line. Union takes place by fibrous tissue, not by bone.

Fracture of the Coracoid Process.—This is also very rare; it is said to occur from a direct blow, from muscular action, and secondary to dislocation of the humerus. But a similar doubt arises as to whether a specimen is not a failure of epiphyseal ossification, leaving the coracoid process united by fibrous tissue. Thus, a coracoid process found post-mortem united by fibrous tissue is to be viewed as an anatomical variation, rather than as evidence of a former fracture. Palpation of the coracoid process by rubbing muscle and fibrous tissue over the projection may easily deceive the unwary, and give a false notion of mobility and of crepitus.

In a supposed case of fracture, whether of the acromion or of the coracoid process, the arm is put in a sling and fixed to the side until pain has subsided; then the arm should be freely used.

Acromio-Clavicular Dislocation.—The commonest form is the displacement of the acromion downwards by a blow on the point of the shoulder, leaving the outer end of the clavicle projecting. This is called by some displacement of the outer end of the clavicle upwards, but wrongly so, for the clavicle remains in place. It may be complicated by rupture of the trapezius, and there is inability to raise the arm above the shoulder as long as the dislocation remains unreduced.

A pad is placed over the shoulder, and strapping firmly passed over it and under the elbow, so as to push up the displaced acromion.

The acromion has in a few cases been displaced upwards.

Tubercular Disease of the Scapula.—It generally begins in connection with one of the epiphyses, and if the first abscess or sinus is not thoroughly treated, the whole body of the bone may become affected and require removal.

Septic Necrosis.—It may arise from an injury or form part of a pyæmic process. Incision, erasion, or removal of all necrosed bone is required. The scapula shows little tendency to resist a tubercular or septic process, and the edges of a partial resection are not disposed to repair, but to continue the diseased process.

Tumours of the Scapula.—Gummata have first to be excluded. The sarcomas are usually not very malignant, being either myeloid-sarcomas, osteo-sarcomas or chondro-sarcomas. However, if not removed in time, they tend to involve the axillary vessels or the chest wall.

Excision of the body of the scapula is required; partial resection is only followed by recurrence in the remaining portion owing to infiltration of cancellous tissue outside the apparent margin of the growth. If the axillary vessels become so involved that they cannot be separated, amputation of the upper extremity will become necessary. When once the growth invades the chest wall it is best left alone, for the removal of a portion of the chest wall will put the patient's life in immediate danger without any prospect of cure.

Excision of the Scapula.—A T-shaped incision is made along the inner border and along the spine, and the skin well reflected. The trapezius and then the levator anguli scapulæ are divided along the upper border, and the suprascapular and posterior scapular arteries clamped if possible before division, the one at the notch, the other at the superior angle.

The bone is drawn outwards and forwards, whilst the rhomboids, serratus magnus, and latissimus dorsi are divided. Finally the neck of the bone is cut across.

When there is a doubt whether the axillary vessels have already become involved in the tumour or no, an anterior incision is made in the axilla over the vessels. It can then be seen whether these vessels can still be separated from the tumour, or whether it is necessary to go on to amputation of the upper extremity. If the former, then the vessels are well separated from the tumour, and the excision is proceeded with by the separate posterior incision; if the latter, then the axillary incision will serve for ligaturing the artery and vein as a preliminary to amputation. In cutting across the neck, the shoulder-joint must be avoided, and this is the more important when the excision is for necrosis. The arm after excision of the scapula is but little weakened for underhand work, but the force which can be exerted when the arm is raised above the shoulder is but small.

The Arm.

Fractures of the Upper End of the Humerus.—A fracture most commonly occurs through the surgical neck, or in young people there is an epiphyseal separation instead. A fracture through the anatomical neck is always doubtful, for traumatic or rheumatic arthritis is difficult to exclude. Compound and comminuted fractures are caused by bullet wounds, those of the left side predominating from that shoulder being in advance of the other whilst firing.

The fracture through the surgical neck runs transversely between the tuberosities above and the insertions of the teres major and latissimus dorsi below, along the line of the united epiphysis. It is generally unimpacted, but the lower fragment may be driven upwards into the head. It is generally caused by direct blows, but may be indirectly due to falls on the hand or elbow, and has been produced by muscular violence whilst throwing a ball. The displacement may be slight, or be determined by the direction of the violence, or the lower fragment may be drawn upwards and inwards towards the axilla by the muscles attached to the humerus and forearm, whilst the head is slightly rotated outwards and forwards by the unopposed action of the external rotators. The head of the bone in the glenoid cavity does not move with the shaft, but crepitus is evoked by the movement, unless there is impaction. In either case there is shortening to the extent of an inch.

The epiphyseal separation occurs before twenty; there is not much displacement or shortening, only increased mobility and failure of the head to rotate with the shaft.

A pad is placed in the axilla to push out the upper end of the distal fragment, the shoulder is covered by a cap of guttapercha, and the hand is kept in a sling across the chest. The elbow must hang freely, so that its weight may make sufficient extension. Passive movements are begun gently after fourteen to twenty-one days, not put off till later, or the shoulder will be fixed.

Fracture through the anatomical neck has been diagnosed in old people owing to supposed crepitus after an injury. But any injury may readily set up traumatic arthritis.

Compound and Comminuted Fractures of the Shoulder. —These cases have generally followed gunshot wounds, and have been treated by excision, not only to avoid the danger of necrosis and septic extension, but also in order to retain mobility of the joint. Now, it will be best whenever possible to replace the comminuted fragments, which are still attached by tags of capsule, and to wash out the joint. Passive movements must be commenced as early as possible, without waiting for the wound to heal. In severe cases, attended with injury to neighbouring parts, ankylosis will be inevitable; the choice then lies between a primary and a secondary excision, and will depend upon the condition of the patient and the facilities for surgical treatment.

Stromyer's wedge-shaped triangular cushion keeps the arm a little way from the chest and in a comfortable position, both when lying down and when up.

Dislocation of the Shoulder—Scapulo-Humeral Dislocation.—The dislocation into the axilla, called by some subcoracoid, by others subglenoid, is the commonest of all the dislocations in adults, but is rarely met with before puberty. The head of the bone tears a hole in the capsule in front of the attachment of the long head of the triceps, and passes downwards and forwards, according to some to rest below the coracoid process above the tendon of the subscapularis, the anatomical neck being in contact with the anterior edge of the glenoid cavity. According to others, the head lies on the subscapularis tendon in front of the inferior costa of the scapula and the insertion of the triceps. But this difference as to position is unimportant.

The dislocation occurs when the arm is abducted, and may be due to the weight of the body falling on the hand or elbow, or from the muscular violence caused, especially by the latissimus dorsi—*e.g.*, whilst being dragged along by the reins after being thrown out, or being caught by the arm during a fall down a hatchway or well of a lift, and also whilst holding a weight above the head, and during swimming. It may also occur from direct violence, *e.g.*, a fall on the shoulder, and may then be complicated by fracture.

The signs of a typical dislocation are that the head of the bone is felt in the axilla, which it distends downwards, whilst it is absent from the joint, and no longer causes the deltoid to bulge; on the contrary, there is a depression beneath the acromion. The head of the bone is relatively fixed so that the humerus cannot be easily rotated. Owing to the position of the head of the bone, the elbow stands 2 or 3 inches out from the side, and a little back, for the axis of the humerus is directed towards the axilla. The elbow cannot be brought to the side without causing pain. At any rate, the hand cannot touch the opposite shoulder at the same time, for the elbow cannot, even if forced to the side, be brought

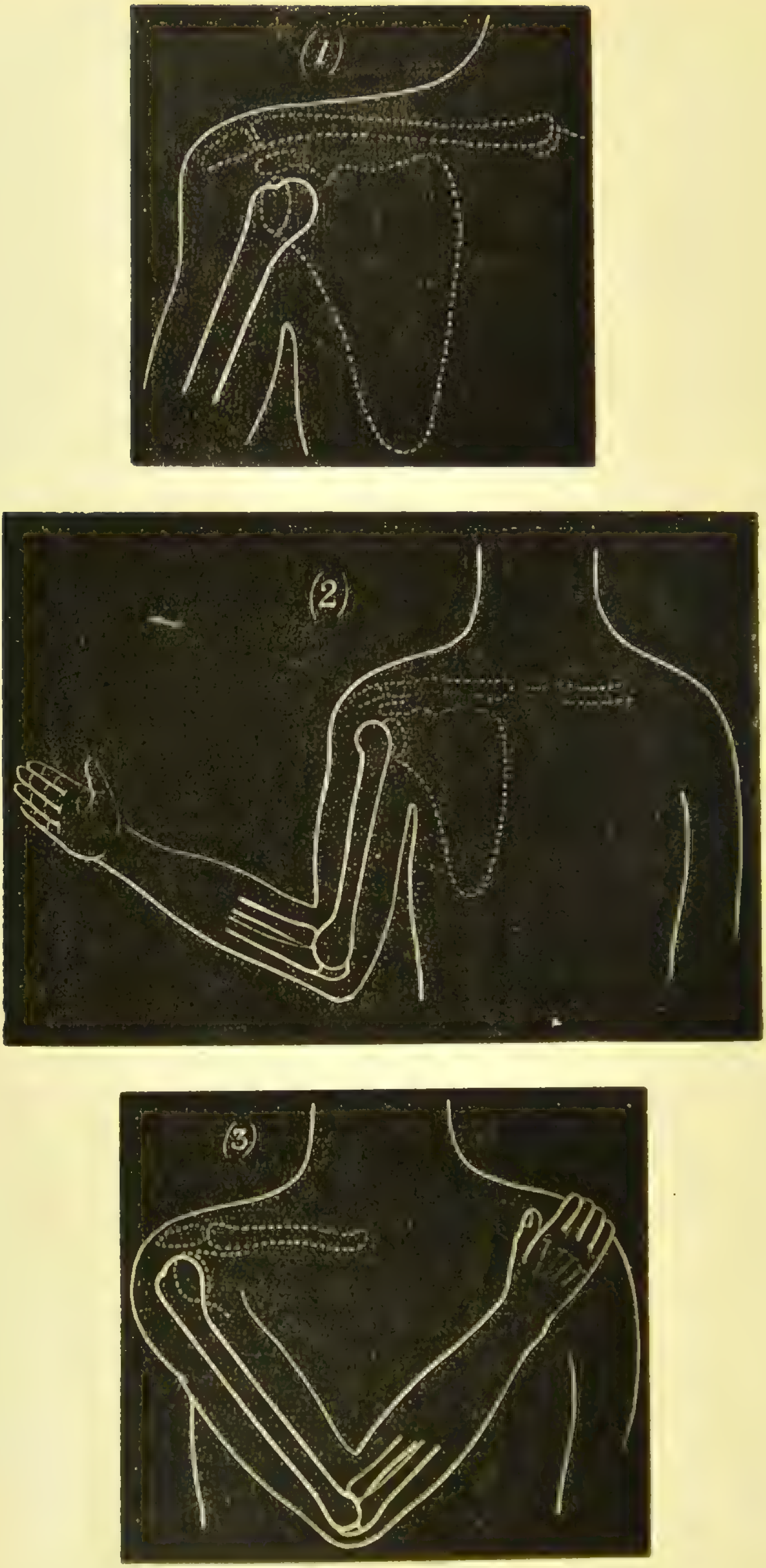

FIG. 97.—DISLOCATION OF SHOULDER.

(1) Sub-coracoid dislocation; (2) reduction: first stage; (3) reduction: final stage.

sufficiently forwards. The head and body inclines to the injured side to relieve nerve pressure, and this makes the elbow lower, and so the arm apparently longer, but there is no real lengthening.

Complications.—There is rupture of the external and internal rotator muscles, according to the violence producing the dislocation. This may render the arm weaker after reduction, especially if the long tendon of the biceps be torn. Stretching, or even rupture, of the circumflex nerve may also be followed by weakness and muscular wasting. There may be a fracture, so that the head of the bone or part of it is loose in the axilla.

The rarest and severest complication is an axillary aneurysm. Subluxations occur in which the capsule is not ruptured, and in which reduction is easy. Indeed, complete dislocations have been found with the capsule unruptured, and this is especially the case in recurrent dislocations.

Double dislocations have been met with. Compound dislocations are very rare.

If a dislocation remains unreduced, the arm is almost useless. It hangs by the side, wastes, and suffers from venous congestion. The patient cannot make more than a little antero-posterior movement; he cannot get his fingers to his mouth, much less raise his arm to the level of his shoulder.

Reduction of a Shoulder Dislocation.—This is frequently so easy that direct pressure upon the head, along with a little extension and abduction, are sufficient. In more difficult cases, a forcible extension or manipulation by screwing the head into the joint is used. Forcible extension was formerly employed, the prevailing notion being that it was the muscular tension which prevented reduction. Of late years, screwing the head back through the hole in the capsule is most in favour.

1. *Reduction by Manipulation* (see Fig. 97).—By strongly rotating outwards the humerus, the capsule becomes untwisted, and the rent in it patent; by forcible over-adduction the head of the bone is moved from its position into the rent; and by rotation inwards during strong adduction, the head

passes through the rent into the glenoid cavity. This is carried out as follows: The patient is placed on a couch, and the affected shoulder is held steady by an assistant; the surgeon grasps the wrist with one hand, and the elbow—flexed to a right angle—with the other, and then, by means of the leverage afforded by the forearm, he rotates the humerus strongly outwards, whilst he holds the elbow to the side. Next he moves the elbow across the chest towards the opposite shoulder, still keeping up the external rotation until the elbow reaches to the nipple of the opposite side. Then rapid internal rotation of the humerus is made by bringing the hand over the opposite shoulder, and the bone should slip into the joint. If the manœuvre does not succeed the first time, a little more forcible rotation outwards, and a little stronger adduction of the elbow, will be required, also pressure on the head of the bone. An anæsthetic is not necessary for a recent case, but should be given if some hours or days have elapsed, and preliminary circumduction movements will do much to free the head.

2. *Single-handed Method.*—This combines extension with forcible rotation. The patient is laid on his back with the affected shoulder over the edge of the couch. The surgeon stands facing the patient, with his pelvis or thigh against the patient's chest. The affected arm is carried across the surgeon's pelvis, and round his back to the hip adjoining the patient, where it is firmly held by the hand of that side, whilst the other hand grasps the shoulder, and makes pressure on the head of the bone with the thumb. The surgeon then slowly rotates his body away from the couch, and so draws and twists and presses with his thumb the bone into the glenoid cavity.

3. *Extension.*—Extension rarely succeeds after the above manipulations have failed. It may be made parallel to the trunk with the foot in the axilla, or the counter-extension can be made by an assistant using a jack-towel. Extension can be combined with a certain amount of adduction and rotation inwards. It can be made directly outwards by placing the foot against the chest wall. Extension is made directly upwards, the patient lying on the floor, and the

surgeon sits down beyond the patient's head, sets his feet on the shoulders, and pulls the affected arm directly upwards.

It is not wise to employ extension beyond the force of one man, and pulleys have fallen into disuse on account of the accidents which have happened. The axillary artery has been ruptured, the nerves lacerated, the skin of the axilla ruptured ; indeed, the arm has actually been torn off. Of the cases in which the axillary artery has been ruptured, nearly all have died, either immediately or shortly after the ligature of the subclavian, from shock, or later on from gangrene, suppuration, or after amputation.

Old Dislocation of the Shoulder.—If not quickly reduced, inflammatory adhesions form, from which the bone has to be freed under an anæsthetic by circumduction movement before the manœuvres proper to reduction are made. When a dislocation proves irreducible to moderate rotation and extension, the resistance is due to altered portions of the capsule forming a band impossible to stretch. After a month or so, the glenoid cavity begins to atrophy, the head of the bone to flatten, and a lipped depression forms where the bone rests against the scapula, and so reduction becomes impossible from the disappearance of the joint ; and, moreover, the humerus undergoes atrophy, especially in an old patient, and is more easily broken.

An old dislocation is therefore treated by incision, division of the tense bands, and the head replaced in the glenoid cavity, or resected. The incision is the same as for an ordinary excision. The long tendon of the biceps must be protected or sutured if found ruptured. If the normal head returns to the glenoid cavity, and there is not much rupture of muscle, good movement may be regained. When the head and glenoid cavity are changed, when much damage has been done to the muscles and tendons around, and when reduction is difficult, then excision of the head is required. Free mobility of a normal joint is the best result, but the free movement after excision is far better than ankylosis.

Recurrent Dislocation.—This may happen in old people, or where the muscles have been much torn. The bone slips out on any exertion whenever abducted. It may be successfully treated by setting up inflammation—*e.g.*, by injecting 10 per cent. chloride of zinc—or by resecting the excessively loose capsule.

Dislocation with Fracture of the Head.—The head of the bone is in the axilla, separated from the shaft. Sometimes it is easy to push it back into the joint. When this cannot be done, the head should be removed through an incision.

Subclavicular Dislocation.—This is the result of great violence, the head lying under the clavicle, internal to the coracoid process, or this process is fractured, and then the dislocation may be called supracoracoid. The muscles attached to the head of the bone are much torn, as also the biceps, coraco-brachialis, and circumflex nerve.

Subspinous Dislocation.—The head of the bone lies under the spine of the scapula, whilst the elbow is carried forwards.

Ankylosis of the Shoulder-Joint.—This may be the result of a fracture or dislocation, following upon which the arm has not been moved.

A slight injury is very liable to set up dry arthritis, indicated by pain, rigidity, and crackling on movement. The changes are similar to those produced by exposure to cold. When the joint is affected in locomotor ataxia, movement is generally excessive, owing to the rapid wearing away of the bone, but ankylosis may also occur.

The adhesions which first tend to fix the joint should be prevented by free movement. When fibrous ankylosis has already taken place, it is difficult to regain movement even under anæsthesia, on account of the mobility of the scapula. If too much force is employed, a fracture of the upper part of the humerus may be caused. When the application of moderate force fails to bring about movement, and the arm as such is useless, excision may be done. In some cases the patients remain content with the underhand movements obtained by an increased mobility on the part of the scapula.

Incision of the Shoulder-Joint.—The shoulder-joint is but rarely attacked by septic inflammation. The septic inflammation may commence as an acute epiphysitis, form part of a pyæmic process, or extend to the joint secondarily. Tubercular disease in a subacute or chronic form is rare compared to similar affections of the hip or knee, but may occasionally be met with, commencing especially from the epiphysis in young children.

The incision is made between the pectoral and deltoid muscles; the long tendon of the biceps is carefully exposed and drawn outwards. If a counter-opening is required behind, this must not be made so low down as to injure the musculo-spiral nerve.

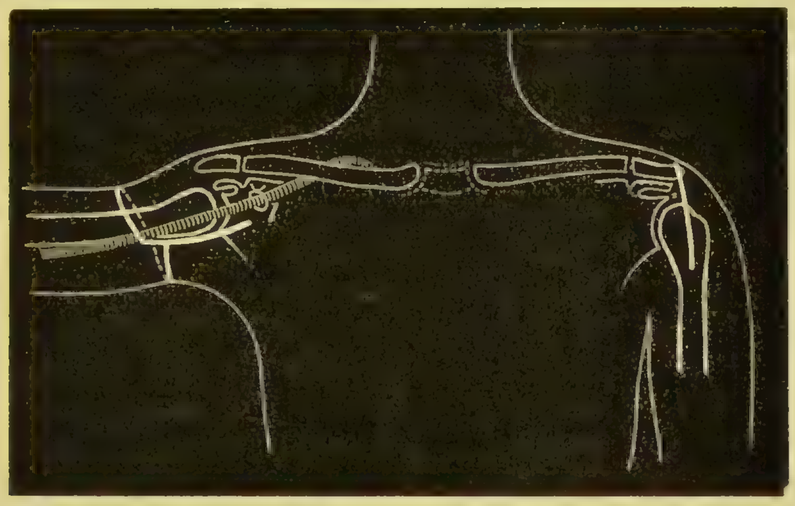

FIG. 98.—OPERATIONS AT THE SHOULDER-JOINT: RIGHT SIDE, AMPUTATION BY RACKET-SHAPED INCISION; LEFT SIDE, ANTERIOR INCISION.

l, Ligature of the axillary artery at the commencement of the operation.

Excision of the Head of the Bone.—The anterior incision is used, whilst avoiding in particular injury to the biceps tendon. After the separation of the muscles attached to the head, the bone is dislocated through the wound and sawn off. In clearing the neck, the musculo-spiral nerve and its deltoid branch must not be injured. Movement is commenced as soon as possible.

Amputation at the Shoulder-Joint.—A longitudinal incision along the inner border of the anterior axillary fold exposes the axillary artery and vein, which are both securely ligatured. A circular cut is then made down to the bone at the level of the insertion of the deltoid muscle. The skin flaps are retracted, and the tendons of the scapular muscles attached to the head of the bone divided, by rotating the head.

If there is any difficulty about first securing the vessels, owing to the extent of the tumour, it is best through a preliminary incision to ligature the third part of the subclavian artery and vein.

Amputation of the Upper Extremity.—This is done for tumours of the humerus, scapula, or clavicle, which have extended so far as to involve the main vessels in the axilla. The essential preliminary to the operation is the ligature of both the subclavian artery and vein on the first rib. To do this, the ordinary operation for ligature of the third part of the subclavian may be available. If not, the middle of the clavicle must be cut away; the vein is exposed, and, after a double ligation and division, the artery is reached. The flaps are fashioned according to the tumour, as much of the skin of the arm being used as required. The suprascapular and posterior scapular arteries can be easily caught whilst dividing the brachial plexus. The only other vessels will be those coming from the spine.

The Axilla.

Incision of an Axillary Abscess.—Small and superficial abscesses originate in the hair follicles, owing to the collection of sebaceous material and the rubbing of clothes.

A deep abscess originates in the glands, unless it follow on a wound or is due to disease of the shoulder-joint or adjacent bones. The incision is made midway between the axillary folds, and forceps are then thrust through the abscess wall.

Excision of the Axillary Lymphatic Glands.—Septic inflammation may follow on a wound of the finger or other part of the arm. If the primary wound is freely scraped and treated antiseptically, the glands may subside with hot fomentations and belladonna application. Suppuration may quickly ensue. The most dangerous form is attended by great swelling of the glands, which are surrounded by much œdema enclosing many foci of suppuration. The patient's life is in danger from septicæmia. The glands should be excised at once, and the wound filled with gauze. In addition, streptococcus antitoxin may be administered.

Subacute and chronic enlargements may be due to syphilis or to a vaccinia sore. The enlarged glands sometimes become tubercular, but much less often than in the neck. Chronically enlarged glands may be a source of neuralgic pains in women, and if the axilla is cleared out the painful nerves should be removed as well.

Lymphadenoma forms a soft painless mass of glands, sometimes traceable to a lesion. The glands are freely movable, and show no sign of inflammation. If arsenic or iodides fail, excision is required, and this becomes urgent, supposing the glands to continue to increase.

Malignant disease is generally secondary to the breast, but may also be due to epithelioma on the upper limb.

Axillary Artery.

Punctured Wound.—The wound is enlarged, so that it may be disinfected and any bleeding-point tied. Meanwhile the third part of the subclavian may be compressed to control hæmorrhage. It is a mistake to ligature the third part of the subclavian for a punctured wound of the axillary artery. Hæmorrhage continues from the distal end.

Axillary Aneurysm.—A rupture of the axillary artery is followed by extravasation of blood, producing a diffuse aneurysm. The third part of the subclavian is controlled either by compression or by a temporary compressing ligature; the aneurysm is incised, the blood-clot turned out, and both ends of the ruptured artery tied.

Ligature.—Ligature of the axillary artery is required for a wound, for traumatic aneurysm, and at the commencement of the amputation at the shoulder-joint.

The arm is everted and drawn back beyond the shoulder. The incision is made along the inner side of the anterior axillary fold in the extended position. The border of the pectoral is exposed and retracted. After dividing the axillary fascia, the fat is drawn aside with the fingers and forceps until the artery is exposed. The vein runs on the inner side, and the brachial plexus of nerves on the outer, but the artery may be overlapped by either structure. The upper part of the artery is exposed by retracting the pectoral muscle, or, if necessary, by dividing it transversely, the cut ends being afterwards sutured.

Care is taken not to injure the vein or nerves. The complication to be feared after ligature in continuity is gangrene. This danger is avoided by careful exploration in the case of a punctured wound, which may show that a branch has been wounded, and not the main artery. A fine suture has successfully closed a small puncture in the axillary artery. Gangrene is much more likely if the whole lumen of the vein is also occluded. After ligature the arm is wrapped in wool, elevated, and the venous and lymphatic return favoured by gentle stroking towards the trunk. Gangrene, if dry, may remain confined to the finger-tips. Moist spreading gangrene is prevented by antiseptic treatment of the wound. When it happens, amputation at the shoulder-joint is at once necessary.

Ligature of the Axillary Vein.—The axillary vein is always exposed in completely removing the axillary glands affected by cancer of the breast. Its branches are ligatured close to it, but a complete obstruction of the lumen is to be avoided if possible. When the vein is occluded by the excision of the portion adherent to malignant glands, some œdema of the arm is likely to be set up. The arm is laid on a high pillow, and the fingers, hand, and forearm bandaged, or the arm is stroked upwards at frequent intervals in order to aid the venous circulation.

The Humerus—Fracture of the Shaft.

Fractures of the shaft are generally due to direct violence, but may be owing to falls on the elbow, or happen during birth. They have been caused by the muscular force exerted in throwing a ball. The fractures are transverse without important displacement, and are commonest just below the middle. The direct fractures may be compound, also comminuted, and in such cases the musculo-spiral nerve may be injured, as shown by the wrist-drop.

An internal angular splint should be applied, with three short strips or a piece of Gough's splintage over the fracture. The hand is put in a sling, but the elbow must hang freely. To support the elbow is to cause overlapping of the fragments and shortening. After the splint has been applied, the length of the bone is compared with that of the opposite side, and if there is still shortening a weight is hung on the angle of the splint, or extension is made by strapping, the pulley being fixed on the back of a chair standing beside the bed. The elbow is kept flexed at a right angle for three weeks, lest the lower fragment should be moved.

Ununited fracture is not uncommon, due to movement at the site of fracture, or secondary to comminution and necrosis.

Rubbing the fragments on one another, injecting chloride of zinc (10 per cent.), or resection and wiring the ends of the fragments together, are means employed for obtaining secondary union.

Fractures of the Lower End of the Humerus.—In transverse fracture not extending to the elbow-joint, the line runs in an adult just above the condyles, where the bone is weakened by the junction with the different texture of the shaft and by the coronoid and olecranon fossæ. In the young, however, the separation is along the epiphyseal line, which runs through the point of the condyles, so that the line is neither above nor below the condyles.

The T-shaped fracture into the elbow-joint is not only a transverse fracture, but also a vertical split in the lower fragment between the trochlea and capitellum.

Either the external or the internal condyle may be fractured. Fractures of the lower end of the humerus take place after falls on the elbow, or by direct blows, such as the kick of a horse or a bullet. The T-shaped fracture is the result of the more severe forms of violence, and it may be comminuted.

The diagnosis is made by finding that the condyles move on the shaft and give crepitus, indicating a transverse fracture. In addition, the condyles move on one another when there is a T-shaped fracture. On account of the swelling about the elbow, it is often extremely difficult to detect the kind of fracture. A skiagraph should be made.

It is important to distinguish the T-shaped fracture involving the joint. Passive movements of the hand, and pronation and supination of the forearm, must be begun from the first, and as soon as possible flexion and extension movements. In severe smashes, including compound fractures, however, it may be better to treat the case for firm ankylosis.

A transverse fracture not involving the joint should be kept with the elbow at a right angle for three weeks, because the danger is from non-union, and the elbow-joint not being involved, its movements will be regained.

Fractures of one condyle when they involve the joint must also be treated by free passive movement from the earliest date.

Rupture of Muscles of the Arm.

Rupture of the Biceps or Triceps Muscle.—Whilst lifting a weight, a man may meet with a sprain of the biceps, consisting of a rupture of a few fibres. In the more marked cases, the belly of the muscle is largely torn away from the long head, or the tendon of the long head itself is ruptured. The belly of the muscle appears unusually prominent in the middle of the arm, whilst there is a depression immediately above. In the slighter forms the loss of power is largely regained by exercise, favoured by hypertrophy of the short head of the muscle and of the coraco-brachialis. In the most complete rupture in a powerful man whose work entails heavy lifting, the adoption of an expectant treatment will prevent the patient from ever regaining much strength in the arm, and so from working as before. In such a case the ruptured muscle should be sutured.

The triceps muscle may also be ruptured during forcible extension, the most severe form being a complete rupture of the lower tendon. The same line of treatment is adopted as in the case of the biceps.

Musculo-spiral Paralysis.

1. **Crutch Palsy**, from resting on the cross-bar of the crutch. The first sign is a weakness of the extensors of the

wrist, which may go on to complete paralysis and contracture. It is avoided by a well-padded cross-bar and by a handle in the middle of the shaft of the crutch, so that a portion of the weight is borne by the hand and arm, and also by exchanging the crutch for a stick.

2. **Sleeping Palsy**, from the arm resting on a hard object. It is most often seen in drunkards after a prolonged sleep, following on a carouse. Massage and electricity may prevent the muscles from wasting, pending the restoration of the nerve influence.

3. **Injury.**—If caused by an incised wound, the nerve should be united at once. If after a subcutaneous injury, whether a fracture or not, the case is watched in anticipation of gradual recovery, massage and electricity being used for the muscles. Failing recovery of the nerve, it must be cut down upon, and freed from inflammatory adhesions, or resected and united.

The Supratrochlear Lymphatic Gland receives the lymphatics from the little and ring fingers corresponding to the distribution of the ulnar nerve. An acute abscess will require incision; a chronic enlargement, counter-irritation by iodine liniment or mercurial ointment. A tubercular gland is excised.

Lymphangitis may be seen in the arm, and yield to treatment: hot boracic fomentations and belladonna extract. Abscesses, single or multiple, in the course of the lymphatics require early incision.

Varicose Veins are very rarely met with, but following on a congenital varicosity, it may be necessary to excise, as in the leg. A dilated vein may burst beneath the skin, and form a blood-cyst with thick walls requiring excision. The veins about the elbow were in former days the seat of septic inflammation after venesection.

Acute Inflammation of the Humerus.

Acute epiphysitis commences at either epiphysis, especially the upper, and extension may take place to the shaft or to the neighbouring joint. An early incision may prevent this. If the epiphyseal cartilage is destroyed at the upper end, there is marked diminution of growth.

Acute periostitis and necrosis of the shaft begin in the centre of the shaft, or spread from an epiphysis. A free incision may save the shaft, or more or less of the shaft may form a sequestrum. This should be removed before the periosteum has been destroyed by ulceration; then new bone may form. If sufficient new bone is not quickly produced, the process may be hastened by bone-grafting.

When no new bone has formed, the application of a fixation apparatus will enable the patient to make use of his arm.

Malignant Disease of the Humerus.

Periosteal Sarcoma.—This is an especially malignant type, attacking the shaft, growing either from the periosteum or from the subperiosteal bone, and spreading rapidly to the muscles, terminating with secondary growths in the lungs. The texture of the growth, medullary, cartilaginous, or bony, does not make much difference. The diagnosis is completed by incision. It is necessary in all cases to amputate at the shoulder-joint, and if extension has already taken place to the shoulder muscles, amputation of the upper extremity is required.

Central Sarcoma.—A myeloid sarcoma may grow at the upper or the lower end of the humerus. A slow-growing tumour is examined, and if found well encapsuled, and its characteristic appearance being recognised, a resection of the end of the bone is sufficient, and many cases have been cured. If the growth has extended beyond the capsule into the muscles, amputation just above the growth is then necessary.

Amputation through the Arm.

A primary amputation is performed when the limb has been so severely injured that it is becoming gangrenous, or when a septic infection is rapidly spreading. A secondary amputation may be required where extensive suppuration and necrosis have ensued after a compound fracture or septic wound, so that the patient is otherwise threatened by death from exhaustion.

Amputation may be necessary when erasion and excision of the elbow-joint for disease have failed owing to extension to the soft parts.

Gangrene of the arm from arterial obstruction, as compared with the leg, very rarely calls for amputation.

Amputation is the only treatment for periosteal sarcoma of the forearm.

Amputation through the arm can be done at any point below the upper third; the stump can only be used for carrying a stick or umbrella in the armpit. Any form of flap will do, provided it is sufficiently long: the circular, the racket-shaped or coat-sleeve flap, also antero-posterior, or lateral flaps. In any case only skin and fascia are taken, the flaps are well retracted, the muscles divided in a circle, and the bone and periosteum at a higher level. The essential things are, to avoid a pointed stump, and to cut the nerves very short after the vessels are tied, in order to avoid bulbous ends and neuritis. If the bone continues to grow from the upper epiphysis in a patient before puberty, so that, after healing, the stump threatens to become pointed, the epiphyseal cartilage may be destroyed.

CHAPTER XXXVIII.

SURGERY OF THE ELBOW.

Dislocations of the Elbow-Joint.

The Upper End of the Radius dislocated in Adults.— The head of the radius may be dislocated forwards, or forwards and outwards, or backwards. The anterior and antero-external dislocations are due to direct violence applied to the back of the forearm below the elbow, or indirectly to a fall upon the strongly pronated hand. The anterior, the external and the annular ligaments are either stretched or torn. The head of the radius lies in front or to the outer side of the external condyle, being absent from its proper position. If there is too great a swelling about the elbow to detect the head, its position is indicated by the direction of the axis of the bone as shown by following its line up from the wrist. The forearm is fixed midway between pronation and supination and in half-extension ; it is impossible to flex the arm to a right angle and beyond even under an anæsthetic. Reduction is made by extension, one hand grasping the arm and the other the forearm, whilst the upper end of the radius is pushed back to its position by the knee. Or extension and counter-extension can be made by assistants, whilst the surgeon presses with his thumbs on the head.

The head of the radius may be dislocated by direct violence applied to the head of the bone when partly flexed, or indirectly to falls on the hand likewise when partly flexed. The head of the bone is found projecting behind the external condyle, whilst the forearm is slightly flexed and pronated. Upon flexion to a right angle, the head of the bone projects markedly. Supination is impossible.

By extension and counter-extension the bone is drawn forwards into position, as proved by the recovery of supination.

Dislocation of the Head of the Radius in Children.—In children before the age of six, dislocation of the head of the radius is common, due to traction upon the forearm with or without torsion. There is no tearing of ligaments, but the head of the bone, which is at that age in diameter but little in excess of the neck, slips out of the grasp of the annular ligament. It has been called congenital, owing to the fact that it may occur during birth, *e.g.*, in turning the child in the uterus, or in making artificial respiration. It occurs in early life from swinging by the arm or by twisting the arm behind the back. At the time of the accident a slight click may be perceived, and the arm is held in semi-extension between pronation and supination. The condition is often overlooked, or put down to some trivial cause, so that it escapes reduction for some time. This may lead to a secondary bending of the ulna to accommodate itself to the shortened and fixed radius.

The bone may be reduced as above described, or the arm may be fully flexed, and then the radius screwed into position by gentle pronation.

Unreduced Dislocation of the Radius.—Some movement is regained owing to a new joint forming, but on the whole the conditions following a dislocation remain permanent.

Attempts at reduction by manipulation having failed, an incision is made over the head of the bone, and the bands preventing reduction are divided. But if the joint surfaces have been altered, movement can only be restored by excising the head of the bone.

Dislocation of the Radius and Ulna Backwards.—This dislocation may be produced on the cadaver in two ways, each of which throws light upon the mechanism by which an accident produces this dislocation. If the forearm of a cadaver be fully supinated and then overextended, a crack is heard, which on examination will be found to have been due to the rupture of the anterior and internal ligament of the elbow; then the forearm can be pushed back, the orbicular ligament and the posterior ligament being merely stretched.

A fall upon the palm of the hand produces this kind of dislocation. The second method is the forcible twisting of the ulna inwards until the internal lateral ligament gives way, and with it the anterior ligament, and then the forearm is driven back. This manner of dislocation is illustrated by a fall upon the inner side of the forearm. That it is possible to obtain a dislocation in this way is shown by the fact that a man has sustained this dislocation by a fall on the inner side of the forearm whilst holding a glass unbroken in the corresponding hand. In an incomplete dislocation the coronoid process of the ulna rests on the trochlear surface; in a complete dislocation the coronoid process is lodged in the olecranon fossa. The anterior and two lateral ligaments are then generally torn, whilst the orbicular ligament escapes. The brachialis anticus and the biceps tendons are tense, and the median and ulnar nerves are put on the stretch. The arm is held fixed in slight flexion and pronation. Only forcible passive movements can obtain flexion, but the radius may be rotated, and be shown to have preserved its relation to the ulna.

The olecranon process projects backwards, and becomes more prominent on an attempt to flex the forearm; on extension its tip is observed to be above the level of the condyles. The lower end of the humerus projects into the cubital space, and presses forwards the soft structures.

The bony points may not be perceptible on account of the swelling, but the loss of flexion and extension under anæsthesia, and the shortening of the forearm, are diagnostic of the condition.

The reduction is made by grasping the arm and forearm whilst making extension over the knee. Another method is extension of the arm by drawing on the forearm whilst the thumbs of the surgeon manipulate. Reduction is recognised by passive flexion being regained whilst under anæsthesia. After three weeks it becomes more and more difficult. Free movements are kept up after reduction. Dislocations irreducible by extension occur when the lower end of the humerus perforates the anterior ligament, and so is held buttonholed. An open incision and a cutting across of the olecranon allow the resisting band to be divided, and the olecranon is afterwards united. It is impossible in such cases to get reduction by forcible extension ; fracture of the lower end of the humerus would inevitably ensue.

The dislocations backwards and inwards, and backwards and outwards, are varieties of the backward dislocation. The ulna may be dislocated backwards, and the head of the radius forwards.

A dislocation may be combined with a fracture. Exact details can only be furnished by a skiagraph if there is already much swelling. Reduction may be easy at first if combined with direct pressure. Later on an incision is required.

Compound Dislocations at the Elbow.

All the ligaments being more or less torn, reduction is correspondingly easy. Under antiseptic treatment a freely movable joint may be obtained. The wound should be enlarged sufficiently to wash out the joint. If combined with fracture, the fragments are restored to their position. The ulnar or median nerves may be stretched or ruptured, and, if seen at the time, are sutured. The brachial artery may be obstructed until after reduction. If torn, the vessel is tied and the blood-clot removed. Amputation is therefore only necessary when the arm has been practically torn off beforehand.

Wound of the Elbow-Joint.

The joint is carefully washed out, and an incised wound united, except for a drain. In the case of a punctured wound by a clean weapon, the joint is observed to see if inflammation ensues, on the first sign of which the same measures are carried out. Detached pieces of bone are sutured into position.

Incision of the Elbow-Joint.

A collection of fluid in the elbow-joint is indicated by a bulging of the slack posterior ligament on either side, and above the olecranon, and by a fulness beneath the brachialis anticus. It is generally secondary either to a wound, to disease of a neighbouring epiphysis, or to pyæmia.

An incision can be made behind, externally over the back of the radio-humeral articulation, or internally behind the trochlea, in which case the ulnar nerve is taken care of. Only a small opening into the joint is thus obtained, but it may be sufficient for the escape of pus.

Incision and Erasion, or Partial Excision.

This is required when, in addition to suppuration, there is disease of the synovial membrane and of the bone. Tubercular disease generally occurs before puberty, and therefore at a time when it is important to preserve the epiphyses, so as not to arrest growth. It may be characterized by much thickening of the synovial membrane. Extension of pus is apt to take place insidiously, and to ascend beneath the triceps, or to burrow forwards into the cubital space. It may, however, involve only part of the joint first, *e.g.*, the radio-humeral. Hydrarthrosis, accompanied by a considerable collection of turbid fluid, may be a chronic tubercular process, or due to rheumatism or ataxia. Fibrinous masses may be found loose in the joint.

Incision of the Elbow-Joint, and Removal of Diseased Synovial Membrane—Arthrectomy.

1. A posterior longitudinal incision through the triceps muscle gives a partial exposure of the lower end of the humerus when the halves of the split muscle are retracted. Its advantage lies in the fact that no structures of importance are divided.

2. A posterior longitudinal incision through the skin, with a transverse division of the olecranon process at its insertion into the ulna, gives, on complete flexion, a full view of the interior of the joint without the division of any important ligaments. After the removal of all diseased synovial membrane and bone, the olecranon process can be reunited by sutures or by ivory pegs. In severe cases the joint should be placed at a right angle, and kept fixed until there is ankylosis. In slighter cases, pronation and supination are practised from the first, or even flexion and extension also.

Excision of the Elbow-joint.

Excision is now rarely done for a compound fracture. The fragments of bone are fixed in position, and by removal of all septic material and blood-clot, suppuration is avoided. There follows only a small amount of serous discharge, which can be removed by a drain-tube. The reason why excision was practised for a compound fracture was the freer drainage and more rapid healing obtained after removal of the injured ends. An excision of the elbow, if the ends of the bones are freely removed, is liable to produce a flail-like joint.

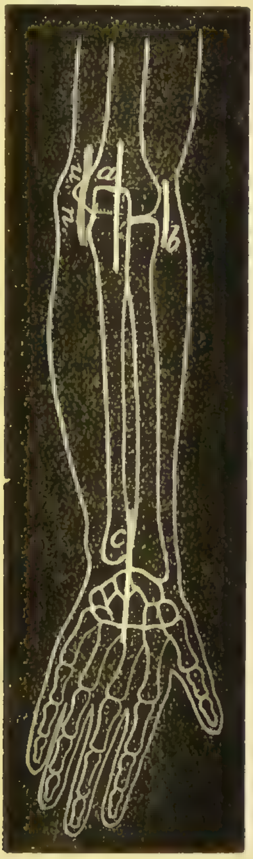

FIG. 99.—OPERATIONS ON THE ELBOW AND WRIST.

a, Line of posterior median incision of the elbow-joint; *b*, line of external incision for the radio-humeral joint; *c*, line of posterior median incision of the wrist-joint; *u n*, line of ulnar nerve behind the inner condyle of the humerus.

Excision is required when tubercular disease or chronic suppuration has passed beyond the stage of partial excision, but the typical operation as performed on the cadaver is but rarely needed, modifications directed to the saving of portions of the bone being introduced in all cases. Exceptionally, the end of one or other of the bones has been widely removed for a myeloid sarcoma, which has not yet extended beyond its shell.

A long posterior incision, extending about 3 inches beyond the joint both ways, is carried down at once to the humerus and to the ulna. The soft parts are separated from the olecranon and lateral aspects, either by a raspatory or by a knife, the edge of which is kept towards the bone. The ulnar nerve is raised and pushed forwards over the internal condyle. The arm is strongly flexed, and held by the assistant, whilst the surgeon cuts off the ends of the humerus, ulna, and radius with a saw, the soft parts being meanwhile fully retracted. It must be remembered that not only may the ulnar nerve be injured behind the internal condyle, but also lower down, where it lies superficially beneath the aponeurosis of the extensor muscles.

After-Treatment.—In all cases the elbow is fixed at a right angle on an angular splint, which is generally applied internally, less often anteriorly, and rarely posteriorly or externally. The objects to be attained are free flexion and extension, along with pronation and supination. Pronation and supination must be commenced within the first week, and flexion and extension in the second week, or not later than the third.

Ankylosis of the Elbow.

An elbow firmly ankylosed at a right angle affords a strong and useful arm, suitable for work of various kinds in which pronation and supination is compensated for by shoulder movements. Extensive compound fractures of the elbow, chronic septic and tubercular disease, whether an operation be done or not, are treated with the object of obtaining ankylosis. As soon as the wound has healed, the arm is placed in a plaster bandage or moulded splint for six months to a year. This rest prevents any recurrence of the inflammation.

Either free movement or firm ankylosis at a right angle should be obtained. Partial movement renders the arm useless. Worst of all is the fixation of the arm in a semi-extended and prone position, for the hand kept hanging down is rendered painful from venous congestion. This is the position the arm tends to fall into when neglected, and especially when movement is incomplete and painful, or when a fixed bandage is removed too early.

Ankylosis in a bad position.—In such a case the patient is put under an anæsthetic, and an attempt is made to flex the arm to a right angle, and to fix it there. Failing this, the adhesions are divided through an open incision, or, if there is ossification, a suitable excision is done.

Flail Elbow.

This may happen after excision when a large piece of the end of a bone has had to be removed for a sarcoma, or when excision for tubercular disease has been done on a young patient, and, the epiphyses being removed, no further growth has taken place. An apparatus should be applied, so as to fix the elbow, and then all the finer movements of the hand may be retained, the long extensor and flexor muscles formerly inserted into the condyles obtaining fresh attachments to the ulna and radius.

Injuries about the Elbow-Joint.

Punctured Wound of the Cubital Space.—The wound is enlarged, and the bleeding-point sought for and tied. The brachial, the radial, or ulnar artery may be injured, also the interosseous, which has been wounded from behind as well as from the front.

Aneurysm of the Brachial Artery.—A traumatic aneurysm was the commonest of surgical aneurysms so long as venesection was in vogue, especially as it was done by barbers and others ignorant of anatomy. It may also be due to embolism from heart disease, and consequently may be found in young people, associated with aneurysms elsewhere.

The aneurysm should be excised after ligaturing the artery above and below. The treatment by direct pressure is not likely to be successful, and may even do harm by favouring extension.

Injury to the Ulnar Nerve behind the Elbow.—A blow may set up neuritis, which is followed by adhesions, as shown by pain, and even paresis, in the distribution of the nerve. The nerve may be involved in a scar or the callus of a fracture, and may be freed from the adhesions by an incision.

The nerve may be dislocated forwards over the internal condyle, and be replaced by thumb pressure. If the dislocation recurs, the nerve can be exposed and fixed in position by fine sutures.

The ulnar nerve may be divided by a punctured wound or during an operation, so as to require suture.

The Olecranon Bursa.

Inflammation in the bursa is generally traumatic. When the elbow is frequently rubbed or bruised, the bursa may gradually develop a thick wall, like the more common patellar bursa.

Suppuration is generally the result of a punctured wound, or due to extension from a neglected abrasion to an already inflamed bursa. The collection of pus in the bursa tends to produce a brawny swelling, and the pus extends subcutaneously upwards and downwards, but shows no immediate tendency to infect the elbow-joint.

If the pus reaches the surface and discharges, a sinus may form, at the bottom of which necrosis of the olecranon goes on quietly. This process may be arrested at any time by free incision and erasion; but failing this, there is ultimately an extension to the elbow-joint.

CHAPTER XXXIX.

SURGERY OF THE FOREARM AND HAND.

Fractures of the Radius.

Fracture of the Head and Neck of the Radius.—Direct fractures of the head may be caused by gunshot wounds and indirect fractures from falls on the hand.

Separation of the epiphysis may occur about puberty instead of a dislocation, the head having increased so as not to slip easily out of the grasp of the annular ligament, and the epiphyseal union not being yet complete. Fractures of the neck are of doubtful occurrence, except in the case of an extensive smash.

Fractures of the above kind are difficult to distinguish from dislocations, which are undoubtedly far more common. Free passive mobility and crepitus are the signs.

The arm is kept flexed to a right angle, and passive movement begun as soon as the patient can bear it.

Fracture of the Shaft of the Radius.—A fracture between the insertion of the biceps and that of the pronator radii teres is due to direct violence, or is caused indirectly by falls on the ball of the thumb. It is argued that the biceps and supinator brevis act unopposed on the upper fragment, tending to fully supinate it, whilst the pronator radii teres and the pronator quadratus tend to pronate. Hence the forearm has been fully supinated on a pillow in order to keep the ends of the bones in apposition. But this is an uneasy if not actually painful position. Union takes place perfectly well with the arm flexed to a right angle and the forearm midway between pronation and supination. Broad front and back splints are applied with a pad over the upper end of the lower fragment. In this position the bones are well apart, and gentle manipulation should be begun before the end of the second week. Fracture of the shaft below the pronator radii teres is not generally attended by displacement, and the same treatment is applicable.

Fracture of the Lower End of the Radius.—The form known as Colles's fracture, taking place within 1 to 1½ inch of the joint, is the only common one. It occurs at the point where the compact bone of the shaft joins the cancellous tissue of the end of the bone, the line of fracture being transverse laterally, but sloping up and backwards antero-posteriorly. The lower fragment is displaced backwards and upwards, and it is also rotated back a little, so that the inferior articulating surface looks somewhat backwards. The lower fragment is also rotated to the radial side about the centre of the radio-ulnar joint, to which it is held by ligaments.

It is met with chiefly in old women, owing to the special senile atrophy at the end of the bone, from falls on the hand, the weight of the body bearing especially on the thenar eminence. Thus, whilst the hand is in over-extension transverse fracture takes place, following upon which the dorsal surface of the upper fragment is driven into the cancellous tissue of the lower end in a direction downwards and forwards towards the palm, hence the rotation of the lower end of the radius backwards; and owing to the special pressure on the thenar eminence the fragment is also rotated to the radial side. The signs of Colles's fracture are the prominence just above the wrist-joint, due to the rotation backwards of the lower end of the radius and hand, with a corresponding hollow on the palmar aspect. The hand is deviated to the radial side, the styloid process of the radius being above that of the ulna; the ulna is prominent on the inner side, and there is a gap between it and the carpus.

Colles's fracture is complicated by a rupture of the internal lateral ligament, or by a tearing off of the styloid process, or rupture of the triangular ligament. In severe cases, as shown by half of the museum specimens in London, the lower fragment is comminuted, and the fracture extends into the joint, being no longer impacted. If compound, it is the ulna which pierces the skin. But it need hardly be remarked that the museum specimens have been taken from fatal and therefore exceptionally severe cases of accidents.

It is diagnosed from sprained wrist and rheumatoid arthritis of old people by the history of the accident and the above conditions, especially the higher position of the styloid process of the radius and the gap on the ulnar side.

Treatment.—The fracture is nearly always impacted, and if left alone the result is a stiff wrist and fingers, which render the hand useless. Hence, when seen at first the impaction should always be liberated by extension on the hand, making quite sure that full adduction is obtained. Special splints are unnecessary. Broad dorsal and palmar splints do quite well. The palmar splint should not extend beyond the annular ligament, and the dorsal splint beyond the bases of the metacarpals. A pad may be placed on the flexor surface of the lower fragment. The arm is kept in a sling, and the fingers well moved from the first, or adhesions of the tendons will occur. After a week gentle extension and flexion at the wrist should be made.

It is sufficient in many cases after complete reduction to wind a broad piece of strapping round the wrist and put it in a sling, allowing the hand to hang freely, so that a thorough deviation to the ulnar side is kept up (see Fig. 26, p. 27).

The errors in treating a Colles's fracture are failure to reduce, and the keeping the fingers stiff until the tendons at the back of the wrist have become adherent.

Malunion of a Colles's Fracture.—If the patient's hand is useless, and she is not too old, the bone is fractured again, or, failing this, the adhesions of the tendons are broken, after which a course of movement and massage is followed.

The lower epiphysis of the radius may separate in boys. It has none of the characteristics of a Colles's fracture, for there is no rotation to the radial side ; the styloid processes remain of the same level, and there is no impaction. There is increased mobility and soft crepitus.

Strapping and a sling are employed, also free movement of the fingers during the first week, and of the wrist during the second week.

Fractures of the Ulna.

Fracture of the Olecranon Process of the Ulna.—This is generally due to direct violence, the line of fracture being along that of epiphyseal union. It has been due to muscular violence alone, and then only the tip is pulled off, into which the triceps is inserted. Undoubtedly, the amount of muscular force exerted at the time of the fracture adds to the displacement, which depends upon the extent to which the aponeurosis is torn. There may be no separation of the fragments, simply a transverse fracture, indicated by increased mobility and crepitus. The fracture may also be compound and comminuted without displacement. If displacement occurs, the gap is widened by flexing the elbow. Owing to the rapid swelling which takes place, diagnosis is only easy shortly after the accident. The separation may appear only when there is an examination under an anæsthetic, or by means of the X-rays. Union may not occur, or only a weak fibrous band unite the fragments, whilst the triceps wastes. In a young patient the separation is at the line of the ununited epiphysis.

If the separation is only slight, and there is no severe injury to the elbow-joint, the arm may be treated in full extension, bandages and strapping being applied so as to pull down the tip of the olecranon and the triceps. At the end of a week, not later, the arm is flexed to a right angle, put on an angular splint, and passive movements commenced. The objection to the extension method is the pain suffered by the patient. Unless the arm is resting on a table or pillow as high as the shoulder, venous congestion ensues. When there is not much separation, and the elbow has been greatly damaged, especially if the fracture is compound, the arm should be at once flexed to a right angle, or ankylosis in the extended position will be the result.

Whenever there is much separation, a consideration of the otherwise inevitable weakness of the arm leads to the adoption of measures for fixing the olecranon in position.

The tip of the olecranon being held in place by the thumb and finger, it is fixed by an ivory peg or a french nail, which is driven from the tip of the olecranon into the shaft of the bone after a preliminary hole has been bored by an awl; the projecting end is cut off, and the skin pulled over the puncture. Or a hare-lip pin may be pushed through the triceps just above its insertion, and another through the aponeurosis of the extensor muscles on the back of the forearm. The two pins can then be drawn towards one another, and held by a figure-of-eight ligature. Passive movement is commenced immediately.

When seen some time after the accident, an incision is made, the edges of the fracture refreshed, and then the ends pegged together or united by silver wire.

Fracture of the Coronoid Process.—It may be remarked that it is not an epiphysis, nor does it project much. It is very doubtful whether it can be pulled off by muscular violence, and whether it has not really been a partial rupture of the brachialis tendon which has been the cause of the pain and swelling after an injury, especially a dislocation backwards. At any rate, it is a very rare accident, and can only happen after a dislocation of the ulna backwards caused by much violence.

Fractures of the Shaft of the Ulna.—They are usually due to direct violence, and are often compound and complicated by a forward dislocation of the radius, less often by a backward one. Any displacement will be governed by the line of the force and by the radial displacement.

Fracture of the Styloid Process of the Ulna.—This is usually a complication of Colles's fracture, but it may also be knocked off by direct violence.

Fractures of the ulna are treated by front and back splints and suitable adjustment of pads. Movements of the fingers and hand are kept up from the first, and gentle pronation and supination begun within a week.

Fracture of Both Radius and Ulna.

Those due to direct violence include the more severe injuries, in which the nerves, arteries, or skin may be also widely crushed. An indirect injury, viz., a fall on the hand, tends firstly to fracture the radius, but where the violence is great the ulna follows the radius, and in the more extreme forms, as, for instance, in falls from a height upon the hands, the ends of the bones may perforate the skin. Displacement may be absent, or accord with the direction of the force.

In a compound fracture both median and ulnar nerves may be lacerated, as also the ulnar and radial artery, and the skin may be more or less torn and raised from the subjacent muscles.

Two splints, each double the breadth of the forearm, are well padded and applied after the arm has been flexed to a right angle, and is held midway between pronation and supination. The palmar splint should reach from the bend of the elbow to the wrist, but no further. If the padding is thick, the pressure of the splints is mainly along the middle line. After being fixed by strapping and bandages, the splints should be so broad as to allow the finger to be inserted between the side of the limb and the bandage. By this plan the veins escape obstruction. The arm is put in a sling, the fingers are moved daily from the first, and pronation and supination are begun gently about the tenth day.

In the case of a compound fracture the vessels are tied, the nerves are united, pockets are sponged out, drained, or slit up, so as to get rid of decomposable blood-clot, and any loss of skin can afterwards be made good by grafting. Primary amputation is only resorted to when the limb below is obviously dead and gangrene commencing.

Amputation of the right forearm reduces the earning power of the patient by a half, or even three-fourths.

Errors in Treatment of Fractures of the Forearm.

There are obvious errors, such as incomplete reduction or relapse owing to splints being misapplied or becoming loose, which can be rectified before union has taken place. If too narrow splints are employed, the arm is tightly grasped in the whole of its circumference, and the bones are squeezed together, and become united by bone, so that pronation and supination cannot be regained. Moreover, venous congestion is promoted by this complete compression of the superficial veins. The worst cases have been those in which plaster of Paris has been applied at once. The plaster contracted on drying, and the arm swelled beneath it, so that severe venous congestion was brought about. The congestion has gone on to gangrene, or, stopping short of gangrene, has set up interstitial myositis, degeneration and contracture, leaving the arm useless. Any tendency to swelling of the hand should be stopped by elevating the limb, by bandaging the fingers separately, and by using massage, stroking towards the trunk. The fracture may be followed by stiff fingers and wrist, owing to the hand being kept without exercise on an unduly long palmar splint. And there may be loss of pronation and supination even in slight cases, owing to want of passive movement, although in severe cases of comminution passive movement cannot be begun soon enough, for fear of delaying union. If the elbow is kept flexed at a right angle, and the forearm midway between pronation and supination, *i.e.*, in the position in which the radius and ulna are furthest apart, the loss of pronation and supination will be partly supplied by abduction of the shoulder, or even slight lateral movement between the ulna and the humerus will develop. Even in such cases free movements of the fingers and wrist are carried out.

Incisions in the Forearm.

These are rarely required, except in the neighbourhood of the elbow-joint or wrist. The course of the vessels and nerves has to be kept in mind, and the incisions made parallel to them. Muscles are retracted, or, if need be, split longitudinally. Acute septic periostitis may commence in the shaft of either bone, acute epiphysitis most generally at the lower epiphysis of the radius, where there is danger of an invasion of the wrist-joint. The abscess is at once opened, and the cavity treated antiseptically. If delay has taken place, necrosed bone is found, and must be removed by aid of a chisel, after which the cavity is dressed with gauze.

The acute epiphysitis may destroy the epiphyseal cartilages, so that growth is arrested in the radius, whilst that of the ulna continues, and eventually the bone becomes curved.

Partial Excision of the Radius and Ulna.

This is required in order to refresh the ends of an ununited fracture, in order to remedy a badly-united fracture, or in order to remove a myeloid sarcoma. If only one bone is involved, the question arises whether its fellow should also be similarly treated. As a rule, if excision of a portion of the radius is necessary, an equal length of bone is taken from the ulna. If it is the ulna which is affected, then the radius may be left unshortened.

After excision of portions of both bones, the ends are fixed in position by silver wire.

A myeloid sarcoma commences in the centre of one end of the bones, especially in the lower end of the radius: growth is slow. After the exclusion of a gumma, the diagnosis is completed by cutting into the tumour. Then the end of the radius can be excised, and the ulna shortened to a corresponding extent.

Periosteal sarcoma grows rapidly from the middle of the shaft of the bone, and may not be noted for more than two or three months. After an incision to complete the diagnosis, the only hope of a cure is by amputation above the elbow, or even at the shoulder, with a clearance of the axillary glands.

Amputation through the Forearm.

A primary amputation is required only when the radial, ulnar and interosseous arteries have all been divided. All the structures on the dorsum, the bones and interosseous membrane as well as the ulnar artery, were divided; the hand was simply hanging by some skin and muscle, in which was the radial artery and the nerves, yet the patient recovered with a useful limb. An extensive burn may widely destroy the skin, or the limb being caught in a machine, and snatched out, the skin of the forearm is stripped downwards over the hand. There is no need for a primary amputation. Skin-grafting may repair much of the loss, which may be found less extensive than at first seemed the case. If the distal end suffers from elephantiasis owing to lymphatic obstruction, elevation and massage are used. A secondary amputation can be done at any time.

Amputation of the forearm is required for septic suppuration extending from the palm. But this can be largely prevented by active treatment, and the stiffest hand is better than any artificial one.

Dislocation of the Wrist-Joint.

Radio-Carpal Dislocations.—These dislocations are very rare, but a Colles's fracture has often been mistaken for a backward dislocation. A dislocation backwards has been caused by a fall on the back of the hand when it was flexed. It has also been produced by a severe crush. The special signs, as distinct from a Colles's fracture, are the rounded upper margin of the carpus on the dorsum, the styloid processes unaltered, still attached to their bones and projecting into the palm, as well as the absence of crepitus both before and after reduction.

The dislocation is reduced by extension, aided by thumb pressure.

A dislocation of the carpus forwards has been produced by a fall, the ends of the radius and ulna projecting plainly on the dorsal surface of the carpus. It is reduced by extension.

The ulna and radius may be separated from one another as a complication of Colles's fracture, or, apart from this, from violent twists of the wrist.

The chief point in treatment is to maintain free mobility of the fingers and tendons about the wrist-joint.

Cut Wrist.

A deep cut on the palmar surface just above the wrist is typically produced when the hand is thrust through a pane of glass. If the wound is superficially treated, *e.g.*, the vessels tied and the skin sutured, or the wound left to itself to heal by granulations, the result is a matting together of all the structures, leaving the hand and wrist rigid. Either or both the median and ulnar nerves may be divided. Division of the ulnar nerve produces a wasting of the hypothenar eminence, of the adductor pollicis and interossei muscles; the hand assumes a claw-like position. There is loss of sensation on the little and half of the ring finger, fibrillation and brittleness of the nails, a glossy skin, which is dusky red and cold, and which is liable to become the seat of ulcers.

Division of the median nerve is shown by wasting of the thenar eminence, and by loss of sensation on the palmar aspect of the thumb, index, middle, and radial side of the ring finger, accompanied by changes in the nutrition of the skin.

A cut wrist is closely inspected, if at all deep. The patient, after being examined as to loss of sensation, is placed under an anæsthetic, and the wound minutely cleaned ; bleeding-points are ligatured, the ulnar or median nerves or tendons are joined. Before anæsthetizing the patient, it is as well to clip with forceps the proximal end of any cut tendon in the wound, and to grasp the forearm firmly, for as the patient is half under the anæsthetic he may struggle, and draw up the proximal end of the tendons out of reach, a thing he cannot do when awake, on account of pain. If, however, a tendon has been drawn up, the sheath must be slit up a little so as to seize it. When all the tendons are sutured, as well as the nerves, in a thoroughly cleaned wound, healing readily occurs, and recovery may be complete.

When a cut wrist has been neglected, much movement can be regained, varying with the length of time from the accident. The circulation is controlled by a band, the scar is incised, each tendon is dissected out and united to its fellow-end. When one end is lost, the other can be joined instead to the sheath of the muscle or to a neighbouring tendon. The nerves are likewise dissected out from the adhesions, their ends refreshed and united. If the ends cannot be brought well together, the proximal end can be stretched until it does; but if there has been destruction of a portion of the nerve, grafting will be needed.

When there is tension, the wound is dressed with the wrist well flexed. The fingers are moved from the first, and the wrist as soon as the wound has healed.

Ligature of the Radial and Ulnar Arteries.

Ligature of one or both of these vessels may have to be done after an incised wound. The uninjured interosseous arteries will furnish sufficient blood. No tight bandage must be put on, lest these vessels be compressed, and the return of the blood through the veins be prevented. The limb is elevated and kept warm.

When either of the vessels is injured by a punctured wound, the circulation is controlled, the wound enlarged, the muscles retracted, the blood-clot wiped out, and so the ends of the vessel can be easily tied.

Ligature of both radial and ulnar arteries at the wrist has occasionally been done to control bleeding in the palm.

The Interosseous Arteries may be injured by a deep puncture, and will generally be controlled by a local pressure.

Diseases of the Wrist-Joint.

Tubercular disease is the common affection for which surgical treatment is required. Septic arthritis is usually gonorrhœal in origin.

Tubercular disease commences either in the radial epiphysis, in a tendon sheath, or in one of the carpal bones adjacent to the joint. The disease may be confined at first to the radio-ulnar articulation, or to some other part, and if erasion is done early, the disease may be checked without much loss of movement in the joint.

Partial or Complete Excision of the Joint.

A long posterior median incision is made, and the tendons are retracted; the diseased synovial membrane is scraped away, and carious bone gouged out. In the more extensive cases, the ends of the ulna and radius—as also the carpal bones and the ends of the metacarpals—may have to be removed, but only so far as the disease has extended. If the bases of the metacarpals have to be sacrificed, the flexor carpi radialis and the extensor carpi radialis longior and brevior tendons are detached, and must then be sutured to the periosteum of the metacarpals beyond. Great care has to be taken not to injure the median and ulnar nerves or the radial artery when removing the scaphoid bone.

The fingers and thumb are moved freely from the first. The wrist had better be kept rigid, to escape the danger of recurrence.

Fractures and Dislocations of the Hand.

Fracture of the carpus is due to direct violence, and is therefore generally compound. By antiseptic precautions necrosis may be avoided.

The os magnum may be subluxated, owing to forcible flexion of the wrist and the stretching or rupture of the dorsal ligament confining the bone. The semilunar bone has also been seen similarly displaced. Reduction is made by extension and thumb pressure.

The metacarpals may be crushed, or are fractured by blows on the knuckles, especially during fighting. A drunken man, by making a bad fist and by hitting out wildly, is especially liable to the accident. A rolled bandage or other pad is placed in the palm, and the hand and fingers bandaged over it. Movement is begun as soon as possible.

Dislocation of the Thumb or Finger.—This is generally backwards, and most commonly affects the thumb, but is also seen in the index and little finger. In each case the base of the proximal phalanx rests on the dorsum of the head of the metacarpal, and is over-extended, whilst the distal phalanx of the thumb and the two distal phalanges of the fingers are strongly flexed. Reduction can be accomplished by extension, aided by thumb pressure. The failure of reduction arises from the head of the metacarpal being grasped by the heads of the muscles attached to the base of the proximal surface, so that reduction is resisted; or else the head has pierced the capsular ligament, which has got between the joint surfaces. Reduction may be accomplished, but the dislocation recurs immediately on the relaxation of the extension.

Forcible extension is made by cutting a strip of soft leather, making a reef knot, and slipping this over the distal phalanges. No excessive force should be used, but in any case of difficulty an incision must be made, and the tendons hooked aside to loosen the head, or the piece of the capsule between the ends of the bones excised.

Fractures of the Fingers.—They are generally produced by direct violence, and are often compound. Mostly the fracture is about the middle. The rule of treatment is to save everything possible, and to get free movement. If, however, the finger becomes stiff, it may be amputated.

Dislocation of the Phalanges.—The dislocation of one phalanx on the other is practically always compound.

Infective Wounds of the Fingers and Hand.

Two factors combine in giving rise to septic inflammation: a lack of resistance on the part of the patient, and also the virulence of the micro-organisms. The first factor—the lack of resistance, from some impairment of general health, or from prolonged work in unhealthy places—comes most prominently forward in the causation of the various kinds of whitlow. The influence of the micro-organisms is seen in the virulent septic infection from septic and erysipelatous cases, post-mortems on patients dead of purulent peritonitis, diphtheria, scarlet fever. Work involving contact with decomposing vegetable or animal material may likewise prove dangerous. Specific diseases may be inoculated, such as syphilis or anthrax.

Whitlow, or Paronychia.—Whitlows are prevented from occurring by squeezing any chance puncture until blood comes, and by keeping the skin clean and protected until it has healed, by habitual cleanliness, by trimming the nails and removing tags of skin, by filling the nails with soap or antiseptic wax, or by putting on rubber gloves before touching septic material. A superficial wound is well squeezed, washed with carbolic acid or sublimate, and covered with collodion. The occurrence of sore fingers or small pustules should serve as a warning that fresh air and rest are required at once. Sore fingers may not heal at all until country air is sought, and meanwhile there is a risk of further infection at any time.

Whitlows commence under the nail, beside the nail, in the skin, or subcutaneously in the pulp of the finger, or deeper still in the neighbourhood of a tendon sheath or joint. The site of the puncture may be clear, or, if the patient's fingers have been in contact with septic fluids, deep suppuration may arise without any sign as to the point of entrance.

Suppuration is indicated by pain and throbbing keeping the patient awake, malaise, or headache, tenderness on pressure; there is increasing redness, swelling, heat, and elevation of temperature. A minute collection of pus may cause a temperature of 102° to 105° F.

The epidermis may be shaved off or snipped away when the suppuration is not deeper than the skin. Washing with 5 per cent. carbolic acid may suffice. If the sore does not quickly heal, it may be painted with pure carbolic acid, or, in addition, scraped under gas.

Subcutaneous Whitlow.—An incision should be made as early as possible, even before suppuration has well started. For an incision which is small and not deep, the skin may be frozen. Otherwise nitrous oxide gas is administered. The incision should be made by preference on the dorsum of an ungual phalanx, sacrificing the nail to preserve intact the sentient pulp; elsewhere on the finger over the middle of the phalanx on the palmar aspect, and the fold opposite the joint spared if possible. The tendon sheath is not opened unless pus has clearly collected within. A loss of power to flex at all the inflamed finger points to the tendon sheath being actually threatened or involved. However, when suppuration has reached the tendon sheath or bone, scraping and free application of an antiseptic is used in order to prevent sloughing of the tendon and necrosis of the bone. Pain is relieved afterwards by a continuous hot bath.

Suppuration in the Palm of the Hand.—This is generally by extension. Œdema of the back of the hand, tenderness to pressure as far as the transverse fold, and the squeezing out of pus, all show that extension to the palm is imminent. Before this, the pus has been confined to a single tendon sheath; as soon as it reaches the palm, all the flexors will be involved. An incision from the palmar fold forwards along the whole length of the finger may arrest the disease.

Pus in the palm is shown by swelling, by loss of movement in all the fingers, by extension of the œdema from the dorsum to the back of the wrist. If not stopped, a further spread will inevitably take place beneath the annular ligament, and pus will collect amongst the flexors above the wrist.

The patient is put under ether, the circulation is controlled by a band above the elbow, a long palmar incision is made the whole length down to the flexor tendons, whilst sparing the annular ligament if possible. All the pus is scraped out, and every sheath and pocket wiped out with a strong antiseptic. Then the circulation is let go, and spouting vessels are tied. The excess of the antiseptic is swilled away, and the wound filled with iodoform and gauze. Dry dressings may afterwards be continued, or the hot arm bath required if there is much pain. Morphine or opium is often necessary, but it should not be given largely before the operation, or the symptoms will be obscured.

A punctured wound may be immediately dangerous to life owing to:

Acute Œdematous Lymphangitis.—The finger is attacked by sharp pain, the temperature rises above 103° F., the lymphatic glands in the axilla quickly become painful and swell greatly; the patient soon wanders, then becomes delirious. Much œdema affects the arm, surrounds the axillary glands, spreads to the chest, and the patient may die within two days before any marked suppuration has set in. In a rather less dangerous case, circumscribed abscesses or widespread cellulitis occurs in the arm.

The most active treatment is urgently necessary. The point of entry is scraped out or excised, and drops of 5 per cent. carbolic acid injected all around. Early incisions are made into any swelling in the arm, which is kept in a bath.

The axilla is freely incised, enlarged and suppurating glands are removed, and the cavity is filled with gauze. Streptococcus antitoxin should be used along with the surgical measures —not alone. Amputation may be absolutely necessary.

Acute Traumatic Gangrene, fortunately rare, may arise from a puncture, or from a more extensive lesion, and is prevented by immediate antiseptic treatment of a wound. When it sets in, there is a rapidly-spreading septic œdema, which causes the skin to change from a dusky red to a bluish-black, and upon cutting into the tissues at any point, sloughing is found in rapid progress. In the course of the second day the swelling will have mounted above the elbow. Amputation through the arm or at the shoulder-joint must be done before the spreading œdema has reached the flaps, and then life may be saved.

Punctured Wounds by Needles or Thorns.—These wounds are important, not only on account of the introduction of septic matter, but also from the needle or thorn breaking off, the fragment remaining buried beneath the skin. There it remains, and, as a foreign body, sets up suppuration, or becomes encysted by a layer of inflammatory fibrous tissue. Its presence may be obvious to the touch, or simply indicated by the painful sensations of the patient. A thorn is only driven in a short distance. If beneath the nail, the nail should be notched sufficiently deep to seize fairly the end of the thorn ; if on the hand, the skin is shaved down until the end of the thorn is exposed. A piece of a needle is more difficult to extract. The painful sensations may not be exactly localized. It is so obscured by becoming surrounded by fibrous tissue that it cannot be felt until actually touched. It must be well exposed, so as to seize the needle firmly lest another break occur. Needles travel not only in the hand, but into the forearm. A needle is plainly shown in a skiagraph, but it cannot be well localized unless the skiagraph be taken from two or three different points.

Chancre on the Finger or Hand.—It is met with on the index-finger in medical men and midwives. Inoculation may take place during a vaginal examination, into the fold between the nail and the soft parts, at the site of a scratch, or into the place from which a tag of epidermis has been torn away. The sore consists of a foul indolent ulcer, covered by dusky-red granulations; but there is very little induration, swelling, or pain. The chancre often passes unnoticed until the axillary glands begin to swell and a rash to develop. Such a sore is followed by secondary syphilis, not differing from the venereal form, and as long as it exists the primary sore is capable of transmitting the infection.

Syphilis may be inoculated by a bite on the hand, or by contact of the knuckles with the teeth of a man affected by secondary syphilis in the mouth.

Tubercular Ulcers and Warts—Anatomical and Post-mortem Warts.—Tubercular ulcers due to inoculation in a subject predisposed to tubercle are very uncommon. An indolent ulcer may be shown to be tubercular by the history of the onset, or by the inoculation of scrapings from the ulcer into a guinea-pig. The ulcer must be scraped and rubbed with an antiseptic.

The most chronic form is that of warts, which show little tendency to ulceration. They arise in some persons from contact with anatomical and post-mortem material. Dusky-red nodular swellings form on the hand or fingers, which generally disappear on change of air and work. The disappearance may be hastened by rubbing in mercury ointment.

Warts are papillomata or overgrowths of the epidermis, due to inoculation. The warts are easily detached, and the blood from the bleeding-point will produce others in the same or other children. The occurrence is favoured by lack of cleanliness and bad food. The warts tend to disappear of their own accord within a short time, which has often been ascribed to the efficacy of a charm. They are easily cured by detaching them and applying a caustic to the bleeding-point. Good hygiene and food will prevent another crop.

Extensive Injuries to Fingers and Hand.

The hand—especially the right hand—is particularly liable to accidents. The accidents in connection with machinery have been much diminished by making chaff-cutters, circular saws, printing machines, thrashing machines, self-feeding; by guarding machinery whilst in motion, so as to prevent the hands from being drawn in. The patients are often to blame for over-confidence and carelessness—*e.g.*, in attempting to oil or shift a belt whilst a machine is in motion. The bursting of a gun blows off the fingers, a chaff-cutter cuts off slices as the hand is drawn in, circular saws make deep cuts. All sorts of crushes occur.

Avulsion of a Finger or Thumb.—A finger or thumb may be torn off, and with it the long flexor tendon, which comes away from its junction with the muscle. Care is needed lest the empty sheath become a channel for the spread of septic infection.

Rupture or Division of a Tendon.—There is loss of active power in the affected finger, but there remains free passive movement. The distal end of the tendon is exposed, and reunited to its proximal, or to some adjacent tendon. When the ends are far apart, the grafting of a tendon from an animal may be successful.

Hæmorrhage from a Punctured Wound of the Palm.

Hæmorrhage from the superficial palmar arch is easily controlled by ligature. Hæmorrhage from the deep palmar arch is more difficult to deal with. The circulation is controlled, then the wound is sufficiently enlarged, and retracted so that the vessel can be caught. This is much better than plugging the wound, which is attended by the following objections, viz., that it is very painful, that suppuration may go on and spread beneath the plug, that the plug is not always effectual, and the ulnar and radial arteries or the brachial have had to be tied, thus making fresh wounds which are liable to become septic.

Gangrene of Fingers.

This may occur from frost-bite, from Raynaud's disease, from blockage of the artery, from injury, or from carbolic acid fomentations. In all these cases secondary removal of the dead part is alone done.

Dupuytren's Contraction of the Palmar Fascia.

This is a chronic inflammation, followed by contracture of the palmar fascia and its processes going to the fingers ; sometimes unilateral, it tends in most cases to be symmetrical. It generally occurs in gouty or rheumatic patients, but the exciting cause is obscure ; there is not much evidence in favour of traumatism.

It begins most often in the fascia and processes connected with the ring-finger, then spreads to the little and middle fingers. At first a slight induration is felt in the palm, preventing complete extension, and puckering the palm ; extension becomes more and more limited, until the finger is drawn tightly down into the palm. Then the other fingers follow, and the hand becomes more and more limited in its usefulness.

The contracture is prevented by gentle massage, by stretching of the induration, the application of mercury ointment, and the wearing of a splint at night, so as to keep the fingers fully extended. If this treatment be really followed, further contracture cannot occur, and the tendency may after a time cease. If limited to a single band, excision may be done, followed by massage of the scar and free movement.

When extensive, each band is divided by puncturing with a tenotome in each of the folds, and the fingers are forcibly extended. The splint keeping up extension has to be worn until the punctures are healed, and is then gradually dispensed with by day, but is put on at night until all further tendency to contracture has passed away.

Webbed Fingers.

One or more of the fingers may be united throughout the whole or part of their length. After very carefully cleaning the hand, the web may be divided down the middle line, and a fine continuous suture inserted, so as to exactly unite the wound down the side of each finger and the fold between them. If the wound heals by first intention, a cure results. If ulceration follows, union may recur, beginning from the proximal end; if so, a plastic operation is done, in which a dorsal flap covers the raw surface of one finger and a palmar flap that of the other.

Supernumerary Fingers or Thumb are rarely of any service; usually they are mere appendages. In their removal, the joint and tendon sheath of the digit to which they are attached are opened, hence septic infection is possible.

Tenosynovitis and Ganglion.

About the wrist-joint, especially in the tendon sheaths of the extensors and of the thumb muscles, is the most frequent and typical situation of tenosynovitis and ganglia (see p. 108). The patient complains of a blow or sprain, or says that he has taken up of late some form of unaccustomed work involving the special use of some of the tendons about the wrist. A ganglion on the dorsum frequently communicates with the wrist or one of the carpal joints. On the flexor aspect a ganglion is also seen in connection with the sheath of the flexor carpi radialis, and the radial artery may lie over the sac. When deep-seated underneath the flexor sublimis tendons, the ganglion will almost certainly communicate with the wrist-joint or with the inferior radio-ulnar joint.

The ganglion either extends and becomes compound, gets thick-walled, and forms an almost solid fibrous tumour, or caseates, suppurates, and forms a fistula. Excision and complete suture is the treatment to be always preferred for ganglion, movement being begun early. The other methods rarely cure, and may do harm.

Compound Palmar Ganglion.

This is a wide-spread tubercular synovitis, the synovial membrane being the seat of tubercles, which cause it to appear swollen, œdematous, jelly-like. The common flexor tendons of the palm are the typical place for this affection, but it may be met with elsewhere, *e.g.*, about the ankle-joint and in the sole of the foot. A soft doughy swelling fills the palm, and bulges above the wrist. If let alone, it extends to the fingers, suppurates, and then the hand has to be amputated, or is left stiff and useless.

The circulation is controlled, a long palmar incision is made the whole length of the disease, so as to expose the affected tendons freely, but avoiding if possible the complete division of the annular ligament. Then the tendons and sheaths are systematically cleaned by scraping and wiping away the sticky, pulpy synovial membrane. The wound is scrubbed out with 5 per cent. carbolic acid, which is afterwards swilled away with water. Iodoform crystals are rubbed in everywhere, and then the wound is sewn up. No pocket should be overlooked. Passive movement is started as soon as the patient will permit of it, and when suppuration has not already set in, the wound may be expected to heal at once, and much movement to be regained.

Tubercular Dactylitis.

It may commence from the inoculation of tubercle bacilli upon neglected sores, upon the fingers of children who are kept dirty and badly fed. It may start as a tenosynovitis, as an epiphysitis in the neighbourhood of a phalangeal joint. But it also begins in a way peculiar to the fingers or toes, viz., in the centre of the shaft of the bone, which it gradually absorbs, whilst a shell is for a time formed by the periosteum. Insidious caries goes on in all these cases.

Thorough erasion, excision, or, in neglected cases, amputation, has to be done in order to prevent extension to the hand.

Rheumatic Affections of the Hands.

After acute rheumatism in children and young adults, fibrous nodules form immediately beneath the skin. They are likely to disappear on the administration of arsenic continued for some time. The finger-joints and knuckles of working men become deformed in later life owing to nodules of cartilage and bone, which limit movement. The tendency is aggravated by hard work and exposure to cold and damp. The hand assumes a deformed position according to the occupation; the right hand of a cabman may become more or less fixed in the position assumed when holding the whip, and the left hand in that obtaining whilst holding the reins. The deformity is partly prevented by wearing gloves, and movement is improved by rubbing with liniments or ointments. Increased movement follows the use of dry hot air, but the hand must also be protected.

Gouty Affections of the Hands.

These are similar to the rheumatic affections, with the addition of nodules containing urate of soda tophi. These nodules occasionally become inflamed and very painful, and the skin even ulcerates, allowing the urate of soda to be discharged. Lead and opium as a lotion, or in an ointment, is a suitable application.

Tumours of the Hand.

Multiple Tumours are occasionally seen, but surgical interference can rarely be of service. Multiple fatty tumours occur, and are congenital in origin. Multiple small aneurysms are met with on the small arteries of the fingers. Multiple enchondromas commence in the centre of the shaft of the phalanges and metacarpal bones, and gradually develop into large masses containing pure cartilage, until the hand is quite useless. Multiple fibromata occur on the nerves, or subcutaneously in connection with a nerve twig. They are not neuromata, *i.e.*, are not made up of axis cylinders. These multiple tumours may cause persistent pain owing to pressure on nerves, or ulcerations of the skin either from direct pressure or from paralysis of the nerve-supply.

Single Tumours—*Epithelial Implantation Cysts.*—A bit of epidermis is carried in by a puncture, where it develops into a cyst, lined by skin like a dermoid cyst, without containing hair or sebaceous glands.

Sarcoma.—Fibro-sarcoma and central myeloid sarcoma are met with. Melanotic sarcoma has commenced as a blackish foul ulcer on the finger, followed by enlargement of the axillary glands. Such ulcers are often overlooked, attention being drawn only to the generalized masses.

Epithelioma.—A horny wart attributed to irritation in the course of the patient's work, seen in an oldish man, should be at once excised, under the presumption that it is an early stage of epithelioma. An epithelioma may arise in a gardener whose hands are often chapped, and who handles soot. It has also occurred among workers in gas-tar products, and such epitheliomas are fortunately of a mild type.

Amputations of the Hand.

The most conservative standpoint must be adopted as to primary amputation. The hand and arm are thoroughly cleaned; every pocket is cleared out; skin, tendons, bones are replaced. A hand appearing utterly smashed may recover and become a useful member.

Secondary Amputations for Injury or Disease.—Gangrenous portions are cut away, and loss of skin is remedied by grafting. Only when suppuration has extended above the wrist, other measures having failed to arrest it, whilst the patient threatens to succumb from exhaustion, is amputation of the whole hand carried out.

Amputation of the thumb, index or little finger, is very rarely carried out, only when all the tendons and bone have been destroyed, and healing cannot be otherwise obtained. A stiff middle or ring finger, whether straight or contracted, is very much in the way, and it is therefore the more readily removed whenever the extent of the suppuration and necrosis renders it probable that rigidity will ensue. Oval, lateral, or antero-posterior flaps are used. The head of the metacarpal bone is preserved when healthy, and when there is enough skin to cover it. As long as the thumb, index or little finger, can be got to heal, the patient will certainly regain much use in them.

CHAPTER XL.

SURGERY OF THE HIP AND THIGH.

Wound in the Groin.

A punctured or incised wound may injure the superficial branches of the common femoral artery; the deep epigastric or circumflex iliac arising from the external iliac; the external iliac itself; the common, superficial, or deep femoral arteries; the corresponding veins; or perforate the peritoneum.

An exploration of the wound is made after compressing the vessel above, should bleeding still be going on. The ligature of small vessels, and the closure of the peritoneal wound, can then be done. If necessary, the external iliac, the superficial or deep femoral arteries, can be ligatured above and below the wound without apprehension as to the circulation in the limb. It is otherwise with the common femoral, for the blood has to pass through a double set of capillaries from the deep epigastric and deep circumflex iliac into the branches of the common femoral, and through their capillaries into the profunda branches, before it can reach the limb. Hence there is a liability to gangrene, which is increased by acute anæmia or by arterial disease. An arterial suture should be tried whenever the wound of the vessel is not large, and the patient carefully watched, so that pressure may be applied should secondary hæmorrhage ensue. The blood returns by the superficial and deep femoral, and by the internal saphenous veins. Hence obstruction of the common femoral vein blocks all three branches, and there is a danger of moist gangrene. The lateral ligature or suture, combined with pressure, may avoid the ligaturing of the common femoral vein, or more than one of its branches.

Swellings in the Groin.

1. **Of Glandular Origin.**—The inguinal chain of glands is enlarged, owing to venereal affections of the penis and urethra. But occasionally the skin of the abdomen up to the level of the umbilicus, or the skin of the buttock and around the anus, is the site of the infection. Diseases of the scrotum involve both the inguinal and femoral chain of glands, whilst that confined to the testis affects the iliac glands. The femoral glands are infected chiefly from the foot and leg, also from the scrotum adjacent to the thigh. Glands in the groin are very rarely attacked by tubercle, but it has occurred subsequent to tubercular inoculation of a circumcision wound.

A strain is often said to cause enlargement, but venereal disease is in many cases really the cause, in others parasites or intertrigo. Excluding these, simple strain may cause an enlargement, but the glands do not suppurate.

As the glands lie between the superficial and deep fascia, there is some mobility of the tumour in the early stages. When the abscess becomes deep-seated and fixed, the absence of expansile pulsation and of a bruit excludes aneurysm, and the absence of an impulse on coughing a hernia.

Inflamed glands are treated by rest, hot fomentations, and the application of belladonna extract. For chronic inflammation, in addition to rest and counter-irritation, firm pressure may be made by a spica bandage.

In acute inflammation and suppuration an early puncture should be made. The common venereal bubo forms in the most internal gland of the inguinal chain. The incision should be the full length of the abscess, so avoiding a sinus. The incision may be made parallel to Poupart's ligament for the inguinal, and vertical for the femoral glands.

A troublesome sinus is a common complication after a small incision. It is slit up and scraped, and the wound filled with gauze.

In a few cases ulceration has extended into a bloodvessel. If not controlled by pressure, the prognosis is bad owing to the sloughing tissues rendering ligature impossible. To stop such ulceration before it reaches the vessel, pure carbolic acid must be freely rubbed in, and when this has been swilled away, iodoform is dusted on, and the whole wound firmly filled with gauze.

Excision of the Glands in the Groin.—When the enlarged glands do not suppurate, nor, on the other hand, diminish, when treated for chronic inflammation, the possibility of a gummatous swelling may be raised, and large doses of iodide administered for a week or two, with the local application of mercury. An indolent mass of glands may be due to lymphadenoma, and then large doses of arsenic may be successful.

When the foregoing measures fail, the diagnosis of malignant disease is rendered likely. Malignant lymphadenoma may start primarily in the glands of the groin. The glands are affected secondarily to carcinoma or sarcoma of the penis, scrotum, anus, or lower limb.

For excision of all the glands in the groin, a vertical incision is made along the line of the femoral artery, and a cross-incision parallel to Poupart's ligament. The skin is turned back, and the glands dissected off from the deep fascia and from the sheath of the bloodvessels. The superficial branches of the femoral artery are clamped, and afterwards tied. The saphena vein, if involved, will require two ligatures, with removal of the intervening portion of the vein.

2. **A Swelling over the Saphenous Opening.**—This generally proves to be some form of femoral hernia. A deep-seated attachment in the saphenous opening may be felt, either through the skin or after cutting through the subcutaneous fat. An impulse on coughing may be present, or it may not be perceptible through the thick coverings, or owing to a mass of omentum being fixed in the ring. The tumour is resonant on percussion when an enterocele, or dull when the mass consists mainly of enlarged lobules of

subperitoneal fat or of omentum, or when the sac is distended by fluid. Abdominal symptoms are very untrustworthy; they may be absent or very slightly marked even when severe strangulation is in progress. Inflammation and suppuration may follow on strangulation or a rupture of intestine; but, also, it may arise in a sac which contains no bowel—*e.g.*, when an ill-fitting truss is worn. An exploratory incision should be made without delay.

A dilated vein in the saphenous opening gives an impulse of fluid, as in the case of other veins, and is accompanied by varicose veins in the leg.

An enlarged gland may be found in the saphenous opening, but not by itself; the rest of the glands will be more or less swollen.

3. **Deep-seated Abscess in the Groin.**—(*a*). A psoas abscess is caused by tubercular disease of the spine, and produces a fulness in the loin and groin above Poupart's ligament. It then extends to the thigh, and appears just below the ligament behind and rather to the outer side of the bloodvessels, or lower down becomes internal, and tends to point in the region of the lesser trochanter. There is no superficial inflammation; fluctuation can be obtained between the swellings above and below Poupart's ligament, and below the ligament the vessels are on a plane anterior to the tumour.

(*b*) An iliac abscess may arise in the same way from tubercular disease of the ilium, and it first fills the hollow of the venter ilii.

(*c*) An abscess, less often a cyst, may be connected with the hip-joint. It is at first circumscribed in front of the joint outside the artery. There is evidence of hip disease, or, at least, the swelling is made more tense by extending the thigh. If the abscess spreads, it does so downwards or laterally, but not upwards above the ligament.

4. **Aneurysm in the Groin.**—A pulsating tumour may appear above or below Poupart's ligament. In the former case it originates from the external iliac, near its origin, or at the point where it gives off its branches. If below the ligament, the aneurysm has probably originated at the bifur-

cation of the common femoral. Since the condition is infrequent as compared with abscesses, it may be at first mistaken for one, unless the pulsation and bruit be especially looked for. The diagnosis will be the more difficult when there is much inflammation around the aneurysm. Digital compression above is often successful: relays of trained assistants keep up pressure for twelve hours or more at a time. Tourniquets are difficult to keep in position on account of the pain they cause; hence ligature of the artery above is the general treatment.

An aneurysmal varix may take place between the common femoral artery and vein after a punctured wound. It should be let alone. When, however, there is a varicose aneurysm —*i.e.*, an aneurysmal sac separating the communication between the artery and vein—the circulation in the limb is in danger, and a ligature has to be placed above and below on each vessel, and the aneurysm excised. If the communication with the vein is by a channel capable of being included in a ligature, the main lumen of the vein is preserved. The internal saphena vein, when it opens above the lesion, must be also most carefully preserved, in order to avoid ligaturing more than one of the three veins.

Ligature of Arteries.

Ligature of the Common Iliac Artery.—Ligature may be done for aneurysms or wounds involving the external and internal iliacs. A median abdominal incision is made, the intestines pushed to one side by sponges, the ureter, as it crosses the lower end of the vessel just behind the peritoneum, is sought for in order that it may be avoided, the peritoneum is divided, and the artery exposed. This may be perfectly easy or difficult on account of œdematous subperitoneal fat. The corresponding vein is carefully separated; its position will vary according to the side and the part of the vessel tied.

Ligature of the Internal Iliac Artery.—A ligature of this artery may be required for an aneurysm or vascular tumour of the buttock. The same operation as for the common iliac is done, the artery being tied just after its origin on the inner side of the brim of the pelvis.

Ligature of the External Iliac Artery.—This may be required for an aneurysm in Scarpa's triangle, also for wounds. It is usually done by an extraperitoneal operation, but the artery must be got at through the peritoneum if the aneurysm has already encroached upon the field of the extraperitoneal operation. The latter incision is made from a point 1 inch above and 1 inch internal to the anterior superior spine of the ilium, to a point ½ inch above and ½ inch external to the middle point of Poupart's ligament. The abdominal muscles are divided, first the aponeurosis of the external oblique, then the fibres of the internal oblique, the division between this and the transversalis being marked by a branch of the deep circumflex iliac artery, tending upwards towards the umbilicus. It is of importance to recognise the transversalis muscle, and the transversalis fascia on its deeper surface. The transversalis muscle and fascia is divided throughout the length of the wound, and the intestines covered by the intact peritoneum and subperitoneal fat, held back by broad retractors. The artery is found at the inner angle of the wound, the vein being behind and on the inner side.

If the wound and ligature are aseptic and the artery free from disease, a puncture of the peritoneum is unimportant. It was formerly most important that the peritoneum should remain intact, in order to prevent the spread of septic inflammation. If, however, there is any likelihood of rupturing the aneurysm wall, the intraperitoneal operation should be chosen. The incision may be median or in the corresponding linea semilunaris, or an incision may be made in the line of the artery, ligaturing the deep epigastric before it is divided.

The Deep Epigastric Artery has been wounded in puncturing the abdominal wall to one side of the middle line for ascites. An abdominal tumour or abscess may push the artery forwards. An abscess in the groin may ulcerate into it. It is rarely injured in hernial operations, being pushed inwards and backwards by the ordinary oblique hernia. In the rarer cases of a direct hernia the artery is pushed forwards and outwards, and may be felt at the outer border of the ring, or may run across the outer part of the sac.

The Deep Circumflex Iliac Artery can be injured by a deep punctured wound. A psoas, iliac, or perityphlitic abscess may ulcerate into it.

Ligature of the Common Femoral Artery.—This artery is easily exposed by an incision over it, which may be longitudinal or transverse. The origins of its branches are uncertain; they may be given off in a bunch, or be scattered throughout the length of the artery. All that are exposed should be doubly ligatured. It is an artery the ligature of which is avoided whenever possible, owing to greater danger from gangrene. The anastomotic circulation has to pass through two sets of capillaries, those uniting the iliac and deep femoral branches, and those uniting the branches of the deep femoral with the tibial arteries.

Ligature of the Superficial Femoral Artery.—This is done for popliteal aneurysm at the apex of Scarpa's triangle. The reasons are that the artery is generally healthy at this point and free from branches, well below the bifurcation, and easily exposed without injuring important structures or muscles. The leg is everted, the inner border of the sartorius recognised, as also the line of the artery. An incision is made 3 inches in length, having its centre at the point where the inner border of the sartorius crosses the line of the artery. The sartorius muscle exposed by the division of the deep fascia is retracted, and the sheath opened well on the outer side, the vein lying internal and behind having to be separated with great care. The only accident, and that not one which ought to occur in an anæsthetized patient, is a puncture of the vein. Then the ligature should be withdrawn, and be applied in a fresh place higher up; the bleeding from the puncture in the vein may be stopped by pressure, or by a lateral ligature.

Ligature of the Superficial Femoral Artery in Hunter's Canal.—The artery lies deeply, especially in a muscular limb, hence the artery is tied here only for a punctured wound. In such a case the vein is also generally wounded, and a varicose aneurysm caused. After applying an elastic band above, an incision 4 inches or more in length is made through the deep fascia. The muscles are separated and retracted, and the artery and vein ligatured above and below the wound. The anastomotic circulation is good.

Injuries to the Pelvic Bones.

Fracture of the True Pelvis.—The pelvis forms a ring which gives way in its weakest diameter when crushed, viz., in the oblique diameter through the rami of the pubes and ischium and the sacro-iliac synchrondrosis of the opposite side. The pressure may be applied in the antero-posterior diameter by crushes of all kinds, or transversely by direct violence, or be indirect from falls from a height upon the feet or knees. The patient is unable to stand when set upon his feet, and he feels as if his body were falling to pieces. Increased mobility and crepitus may be obtained by grasping different parts of the pelvis with the two hands, or by placing one hand on the pelvis and manipulating the femur with the other. The latter method enables a fracture through the neck of the femur to be distinguished; for in that case the hand grasping the femur will the more plainly perceive the crepitus.

Fracture of the rami of both sides, extensive comminution, etc., are found after fatal accidents. Fracture of the pelvis may be complicated by rupture of the urethra, extraperitoneal rupture of the bladder, or in the worst cases an intraperitoneal rupture in addition, by rupture of the vagina, or rectum, or intestines. The later complications are suppuration, necrosis, and the separation of a sequestrum, which may exhaust the patient, perforate a bloodvessel, or ulcerate into the bladder, and the sequestrum become the nucleus of a phosphatic calculus.

Perfect rest in bed until all pain has ceased, and the application of a firm pelvic binder, are required. The complications are treated by drainage and frequent irrigation, and later by the closure of fistulæ, removal of sequestra, etc. The intraperitoneal rupture of the intestines or bladder obviously reduces the chance of recovery to a minimum; nevertheless an immediate suture should be applied.

Separation of the Symphysis Pubis.—This may occur from crushes in young subjects; it occasionally happens during childbirth as an exaggeration of the slight loosening not uncommon at the end of pregnancy; also it is said to have been due to forcible pressure of the thighs outwards, *i.e.*, from muscular action alone, or from contact with the pommel of a saddle. Mobility, but only soft crepitus, will be obtained. The urethra or bladder also may be injured.

Fractures of the Ilium or Ischium.—The spinous processes, or portions of the crest or other prominences, may be knocked off by direct violence without displacement, and without further complications. The accident may be obscured by swelling, and later on suppuration and exfoliation of a sequestrum may take place.

Fractures of the Acetabulum.—There may be a fissured fracture or a separation along the **Y**-shaped cartilage in a young subject, without any displacement of the head of the femur. Or the fracture may be comminuted, and the head driven inwards. The only evidences during life when the head is not displaced is roughness or actual grating, which is hard to distinguish from traumatic arthritis. The impaction of the head of the femur attends violent falls or blows on the trochanter major, following upon which a depression takes the place of the prominence over the trochanter. The limb is held slightly flexed and abducted, shortened from $\frac{1}{2}$ to 2 inches, and the head of the bone may be felt through the vagina or rectum bulging the obturator internus muscle. The head of the bone may be moved with some difficulty, and then crepitus may be obtained.

The femur is reduced by lifting it out, or extension may be made horizontally outwards with a jack-towel placed around the upper part of the thigh, whilst the leg is strongly adducted.

The rim of the acetabulum may be chipped off as a complication of a dorsal dislocation. The reduction of the dislocation by simple extension is easy, but the dislocation as easily recurs when extension is relaxed.

Separation of the Sacro-Iliac Synchondrosis. — This occurs with fracture of the opposite rami, or may happen alone. It is also excessively loosened during labour. Rest in bed must be prolonged until there is firm union.

Fracture of the Sacrum.—It may form part of a fractured pelvis, or be found alone from direct injury, such as falls or blows. In the latter case the rectum may be directly injured, or be pressed upon by a displaced portion of the bone, or may later on provoke suppuration, necrosis, and a troublesome fistula, without there necessarily being a direct communication. The sacral nerves may be involved in the injury and subsequent callus, and be a source of pain, spasm, or paresis of the sphincters of the bladder and rectum.

The rectum must be examined to see whether a fragment can be replaced by pressure, or whether the rectum has been injured. The patient must lie on his face or side, and later on, when sitting up, will require a ring or horseshoe cushion. The patient's bowels should be kept freely open ; this is better than giving opium to produce constipation, for extra pain will afterwards occur from scybala. Suppuration or a fistula will be dealt with according to position, *e.g.*, by superficial incision, by a deep incision beside the sacrum and coccyx to reach the anterior surface of the bone, or by dividing the anal sphincter for communicating fistulæ.

Diseases of the Pelvic Bones.

Tubercular Disease may commence in the sacro-iliac synchondrosis or in the epiphyseal line of the crest of the ilium. It may extend secondarily to the ilium from the hip-joint, or to the coccyx from the rectum.

Sacro-Iliac Disease is indicated by pain over the articulation in walking, and on pressing the two ilia together. A doughy swelling forms over the joint, which, if neglected, gives rise to an abscess, bursts, and caries rapidly spreads to the sacrum and ilium. The pain must be treated by rest, tonics, and local counter-irritation. As soon as a swelling forms, it should be incised, and the articular surfaces thoroughly scraped. If caries extends, a more extensive gouging is required; but with the extension of the disease the prognosis becomes more unfavourable, and the patient may die eventually of exhaustion, amyloid disease, or of spinal meningitis.

Disease of the Ilium and Acetabulum.—A local abscess may form over the crest of the ilium on its dorsal aspect, or fill the iliac fossa. An early incision, with as complete erasion as possible, must be done; the cavity is afterwards dressed daily with iodoform gauze. An extension to the ilium from the hip-joint is treated by free gouging as an addition to the excision of the head of the femur, or to amputation at the hip-joint. Wide excision of the acetabulum and ilium has been done with success.

Disease of the Coccyx.—A tubercular ulcer of the rectum may extend and cause caries of the coccyx, which necessitates removal.

Tumours of the Ilium.—Sarcomas may attack the ilium, and excision may be tried if still limited; but the operation is not hopeful, on account of the probable infection of the whole bone. A well-localized myeloid sarcoma offers the best chance of cure.

Sacro-Coccygeal Tumours form large masses, attached especially to the anterior aspect of the sacrum and coccyx. They are congenital in origin, and may be of large size at birth, or, continuing to grow after birth, become pyriform tumours, projecting downwards from the buttock. They are of a mixed fibro-cartilaginous texture. Removal can rarely be undertaken with any hope of saving life, on account of the wide attachment and the early age of the patients.

The Buttock.

Abscess.—A gluteal abscess may be primary, following a wound or chill, starting in the loose connective tissue or in one of the bursæ; or it may be an extension from disease of the hip, pelvis or spine, or from the rectum. When deep-seated, it must be distinguished from an inflamed gluteal aneurysm. Puncture with a fine aspirating needle will exclude aneurysm. It is opened by a longitudinal incision and the thrusting in of forceps. The abscess may ulcerate into the gluteal artery, and a ligature be necessary.

Gluteal Aneurysm.—It occurs especially in negro women. It has also been caused by the extension of an abscess. A rapidly-growing sarcoma pulsates in a similar way. It will generally be best to ligature the internal iliac first of all, and afterwards excise the aneurysm. If sudden hæmorrhage has to be controlled, this must be done either by compressing the abdominal aorta against the promontory, by compressing the internal iliac against the psoas muscle through the rectum or vagina by the finger or by a ruler held in the hand (Davy's lever), or by thrusting in the finger and compressing the bleeding-point until the wound can be enlarged sufficiently to secure the artery.

Ischial Bursa.—It used to occur frequently in weavers, who slid on their buttocks whilst throwing the shuttle backwards and forwards. A tense swelling is formed over the ischial tuberosity. An acute inflammation with exudation of fluid is relieved by aspiration. When chronically enlarged, with thick walls, excision is required. Supposing it to be neglected, suppuration may occur, and a sinus develop, owing to the bursting of the abscess, also caries of the ischial tuberosity.

Sciatic Neuritis.—Sciatica includes sciatic neuralgia, pain felt in the course of the nerve without any local lesion, and sciatic neuritis from some local lesion.

Sciatic neuralgia may be due to anæmia, malaria, gout, syphilis, disease of the spinal cord, or be a functional neurosis. Sciatic neuritis arises from cold, from injury of all kinds, from vertebral disease, such as cancer, syphilis, tuberculosis or exostosis, from pelvic inflammation in women, or from pressure of the child's head or the forceps during labour. It is also caused by distension of the sigmoid flexure and rectum by fæces, or by a sciatic hernia.

The patient feels pain in the course of the sciatic nerve and its branches, and if there is a local neuritis, special tenderness may be felt on pressure, also hyperæsthesia in the corresponding cutaneous nerves. In bad cases there is wasting and contracture of the leg.

Sciatic neuralgia has to be treated medically. If there is a local neuritis, this may be relieved by removing the cause. Neuritis in the pelvic portion of the sciatic nerve is especially relieved by systematic dosing with castor-oil. Outside the pelvis and down the back of the thigh, the neuritis is treated by rest and counter-irritation. The latter consists in blistering or cauterizing the skin along the course of the nerve. When these measures have failed, the nerve may be stretched. Incision and nerve-stretching may be successful because some removable lesion is found at the site of operation—*e.g.*, a collection of fluid, a needle, spiculum of bone, or bullet. The stretching of the proximal end may break down some adhesion in the sciatic foramen or pelvis. Stretching the distal end may give rest to over-excitable nerve ends, and allow normal nutrition to be re-established.

The sciatic nerve may be slightly stretched by fully flexing the lower limb at the hip whilst keeping the knee well extended. It is insufficient in bad cases, but, on the other hand, no wound is caused. The nerve is now generally stretched through an incision, which is made in the line of the nerve just below the gluteus maximus. The muscles are retracted and the nerve hooked up. Steady traction is made on the nerve in both directions by the pull of the flexed arms, unaided by the weight of the body, and without jerks. The pulling is continued until the nerve, previously tense, lies slack in the wound. Sensation soon returns, and movement is unimpaired. Unfortunately, the pain may return as soon as the anæsthetic condition has worn off.

Dislocations of the Hip—Coxo-Femoral Dislocations.

All traumatic dislocations of the hip are much less frequent than those of the shoulder; only one or two are seen annually in the practice of even the largest hospitals. More than three-fourths are cases of dislocation on to the dorsum ilii, or into the great sciatic notch; the remainder are about equally divided between obturator and pubic dislocations. It is an accident especially belonging to men in adult life. Women and aged men are not so much exposed to accidents. Traumatic dislocation does happen before puberty, but the

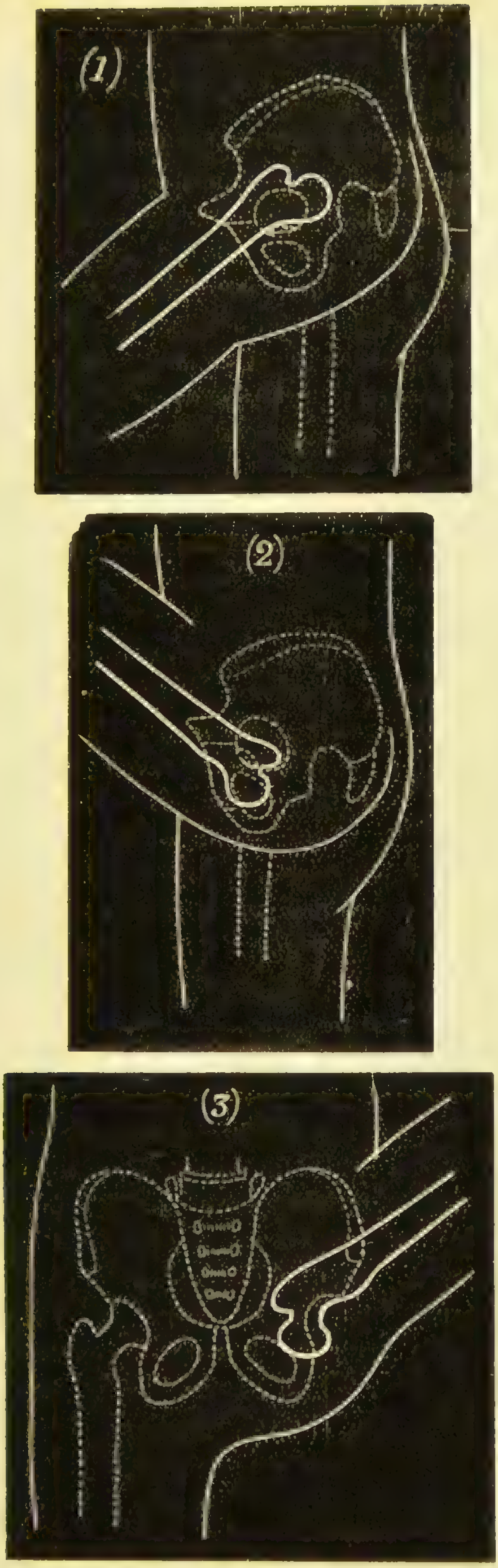

FIG. 100.—REDUCTION OF DISLOCATED HIP.

(1) Dorsal Dislocation; (2) Reduction: first stage; (3) reduction: second stage.

congenital dislocations and the pathological dislocations due to chronic tubercular disease are far more frequent.

The dorsal dislocation, being the most frequent, forms the typical dislocation. There are two opinions as to its production. Astley Cooper taught that it was caused by extreme adduction of the femur when slightly flexed, so that the head was lifted out of the joint and driven backwards and upwards. This opinion was supported by Astley Cooper's dissection, and also finds support now from the history of accidents in which a dislocation has occurred after a patient has been crushed and his legs strongly adducted. Surgeons, in operating to obtain reduction by open incision, have found conditions, such as rents in the upper and back of the capsule and bands, which prevent the head from travelling round the back of the acetabulum, and these accord with Astley Cooper's view of the origin. But another opinion has arisen, owing to the way in which a dorsal dislocation can be produced in the cadaver, and also from the success which attends a manœuvre for reducing the dislocation, deduced from these experiments on the dead body. Experimentally, on the dead subject the dorsal dislocation can only be produced by forced abduction, which rends the capsule downwards and inwards, and produces first an obturator dislocation; then, by flexion and rotation inwards, the head of the bone is made to travel round the acetabulum to the dorsum. Manipulation in the opposite way returns the head to the joint. A dislocation may well be produced in this way by indirect violence; *e.g.*, a man slips whilst carrying a heavy weight on his back, his foot strikes out, and the weight of the body causes a rupture of the capsule and an obturator dislocation; then, whilst falling, the head of the bone is rotated round to the dorsum by flexion and twisting of the foot inwards.

The signs of a dislocation of the head of the femur on to the dorsum ilii can be seen best when the patient is standing up. Then the affected limb is slightly flexed, adducted, shortened one and a half inch or more, so that the great toe rests across the instep of the sound foot, and the long axis of the femur is directed across the lower third of the opposite thigh. The limb can be flexed or adducted a little, but not abducted. The head of the bone is to be felt more or less plainly, moving with the rest of the femur on the dorsum ilii over and behind the site for the attachment of the rectus femoris, whilst a hollow may be felt behind the vessels, and in a thin patient the rim of the empty acetabulum also. The great trochanter is above Nélaton's line, drawn between the anterior superior spine and the tuberosity of the ischium—indeed, may be found to be as high as Bryant's line, drawn horizontally round the pelvis through the anterior superior spines; moreover, the trochanter is nearer the median line of the body (Morris).

If reduced, no pain or other trouble may be afterwards experienced; if not reduced, there remains lameness and limited movement for the rest of life.

An anæsthetic is always required.

Reduction by Manipulation.—The patient lies on a mattress placed on the floor, or on a firm bed, and the pelvis may be fixed by an assistant. The limb is first flexed to a little beyond a right angle, keeping up the adduction already present. When this is done, the thigh may tend of itself to abduct, or this abduction is made accompanied by a slight rotation inwards and then extension. At the commencement of extension a snap will announce the reduction. This manipulation depends upon a part of the capsule, especially the anterior part, the so-called ilio-femoral band, being intact, it makes the anterior intertrochanteric line a fixed point, round which the femur revolves. If it does not occur, the limb will extend but very little, and it should not be forced. If the first manipulation fails, it is repeated, using a little more force, but not so as to cause tearing of muscle or to fracture the neck of the femur, nor by excessive rotation to turn the dorsal into a pubic dislocation. Manipulation will be especially indicated when indirect violence has caused the dislocation.

Reduction by Extension.—The extension is made in the axis of the adducted limb. The surgeon's foot (with the boot off) may make counter-extension by pressing on the ischium, or the counter-extension may be made by a jack-towel.

Both extension and counter-extension should be made steadily, and should not exceed the force of a man each way. Fractures of the neck or shaft of the femur, rupture of a main vein, or suppuration after tearing the skin, may arise from excessive extension. Extension will most probably succeed when the violence has been direct. After reduction, gentle exercises are kept up in bed until pain is gone. When the patient gets about, he must avoid excessive abduction or adduction.

Old Dislocations.—After a few weeks reduction becomes more difficult: the acetabulum is filled with fibrous tissue attached to the capsule and the rectus and pectineus muscles in front; a band of the capsule between the ischial tuberosity and the lesser trochanter may prevent reduction by manipulation, and the capsule may so tightly grasp the neck that the head will not slip back. No doubt, as time goes on the muscles shorten, but it is a great mistake to believe that muscular resistance is the chief obstacle to reduction in a dislocation of long standing.

In case moderate manipulation and extension under an anæsthetic fail, an old dislocation should be reduced by an open operation. A rectangular incision is made along the anterior border of the tensor fasciæ femoris, and backwards over the joint, the head of the bone is exposed, bands preventing reduction are divided, and the acetabulum cleared out. Extension in slight abduction is kept up for a month before passive exercises are begun. If the head of the bone cannot be got back into the joint, it may be excised, but then the patient will always walk lame.

Dislocation into the Sciatic Notch or below the Obturator Internus.—The condition is very similar to the dorsal dislocation, but at the time of the accident the hip is much more flexed. A characteristic mode of causation is by a fall of earth upon the back of a man whilst stooping and working with the legs apart. The patient may be first seen lying with the limb well flexed, but if set on his legs the affected limb is more fully extended, and is not so much shortened as in the dorsal dislocation, so that the great toe of the injured limb touches the great toe of the opposite side. The dislocation is complicated by laceration of the external rotators, and also the sciatic nerve may be involved. If the obturator internus tendon stretches or tears, the head of the bone may slip upwards and become a dorsal dislocation.

The surgeon stands astride of the patient lying on a mattress on the floor; he then clasps his hands behind the upper third of the patient's leg, whilst the knee is flexed to a right angle, and so lifts the head of the femur straight forwards into the joint. Meanwhile an assistant makes counter-pressure on the ilia. Instead of using his hands, the surgeon may put a jack-towel over his head, and so lift forwards the femur from his shoulders, whilst with his hands he manipulates the bone. The method of manipulation for a dorsal dislocation may also be used.

Obturator Dislocation.—The head of the bone passes forwards and downwards, and rests on the obturator foramen; if it travels further forwards, the head of the bone lies in the perineum; if backwards, it is close to the tuberosity of the ischium. The cause of this dislocation is abduction pure and simple, and may be due to a horse falling on his rider, or from a heavy weight upon the shoulders and back whilst the legs are apart. The limb is abducted, and the patient leans to the injured side to relax the tense psoas and iliacus muscles, the buttock is flattened and the adductor muscles tense. The limb is apparently lengthened, but is really unaltered, or actually shortened.

Flexion and slight rotation movements to free the head, or gentle extension, with counter-extension transversely outwards, usually suffice for reduction.

Dislocation of the Head of the Femur upon the Pubes.—The head of the bone lies on the pubes beneath the psoas and iliacus muscles and Poupart's ligament, whilst the great trochanter is over or in the acetabulum. The limb is everted owing to the tense muscles and the anterior portion of the capsule. The vessels may lie to the inner side, or be stretched over the head of the bone, the artery has been ruptured, and a traumatic aneurysm caused; also the femoral vein has been torn. In more severe cases the head of the bone may lie over the brim of the pelvis. The signs of the dislocation are abduction, slight flexion and rotation outwards, or eversion. The head of the bone can be more or less plainly felt, whilst the trochanter may be quite obscured.

Flexion whilst abducted, and then slight rotation outwards, are first tried, or the head of the bone may have to be lifted out of the pelvis, and then drawn into the acetabulum by extension.

There are varieties of all these types of dislocations, but they have chiefly been studied experimentally on the cadaver. In any case they are treated by slight modifications of the manipulation-extension methods. One variety is the everted dorsal dislocation. The head of the bone lies on the dorsum ilii above the acetabulum, whilst the foot is everted. It is generally produced secondarily, either by the patient's attempts to get about or by unsuccessful attempts at reduction.

Compound Dislocations are seen only in fatal injuries.

Fractures of the Neck of the Femur.

The neck may separate from the head, or the head and neck from the shaft. The former is commonly called intracapsular, the latter extracapsular. The clinical diagnosis between the two is difficult.

The **Intracapsular Fracture** typically occurs from indirect violence in an aged person—from falls on the feet or knee, or from a mere twist of the leg. It may also be due to a fall on the great trochanter, although this typically causes the extracapsular variety. The influence of muscle is doubtful. An old person trips, and strives to avoid falling, and is picked up with a fracture; but it remains undecided whether the fracture was due to catching the foot or to the subsequent muscular exertion. In most cases the former is probably the correct explanation.

The signs of the fracture are pain, inability to lift the leg from the bed, except when impacted, which is rarely the case, and the limb lies everted on the bed without the patient being able to turn in the toe. The shortening varies from $\frac{1}{2}$ to 1 inch, and, corresponding with this, the great trochanter is at a higher level, and is less prominent. When impacted, the limb is everted and shortened, but can be raised a little. The shortening is increased in a neglected case from atrophy and further displacement. Crepitus is never well marked, and no great attempt should be made to obtain it, or more laceration of the capsule may ensue. The other signs are sufficient to distinguish a fracture from a bruise or strain.

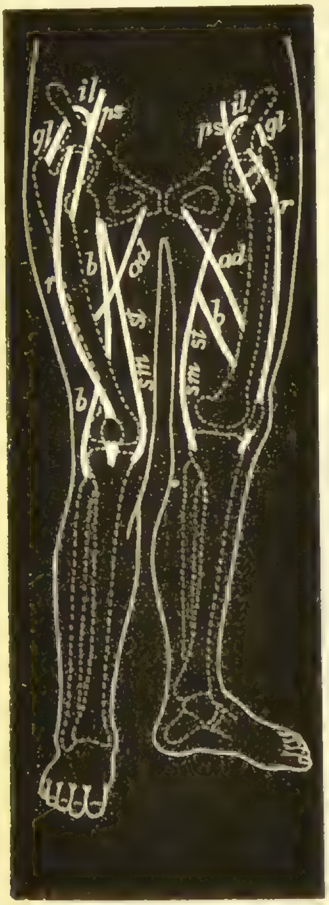

Fig. 101.—Fracture of the Neck of the Femur.

On the left side, as compared with the right, is shown the displacement upwards, and eversion of the injured limb by muscular action. Muscles: *ps*, psoas; *il*, iliacus; *gl*, gluteus; *r*, rectus; *ad*, adductor; *b*, biceps; *sm st*, semimembranosus and semi-tendinosus muscles.

The fracture in such cases is found to run between the head and neck, and is predisposed to by the atrophy of the neck which goes on in old age, especially in women, along with a diminishing angle between the head and neck and the shaft of the femur.

If the patient is not very old, and bears lying in bed well, the fracture is reduced by extension, and then a long splint and extension by weight are kept on for a month. However, in the majority of cases the patients are old and feeble, who, if kept on the back, are likely to develop respiratory difficulties from slight hypostatic pulmonary congestion, or bedsores. Such cases should not be kept in bed any longer than absolutely necessary. An old woman may be sat up in a chair after putting on a plaster of Paris spica bandage, with the hip flexed at a right angle, so that she can stay up all day comfortably. As soon as the pain will allow, she should get about with a stick, the question whether union or non-union occurs being unimportant as compared with the patient's general health.

Extracapsular Fracture happens at the junction of the neck with the trochanters. It is generally due to direct violence applied to the great trochanter in patients younger than those in which the intracapsular form occurs. The fracture is in the majority of cases impacted.

The signs of the fracture differ from those of the intracapsular in the impaction and in the more marked shortening, which may be 1½ to 2½ inches or more. The trochanter is also wider than normal, and there is generally much more bruising about the great trochanter. The line of fracture is along the intertrochanteric line, and by a continuation downwards of the force the neck is driven like a wedge into the shaft. If the force is extreme, the neck splits the great trochanter off from the shaft. Then, there are three fragments—the head and neck, the great trochanter, and the shaft; there is much shortening, and crepitus is easy to obtain.

It is generally necessary to separate the impaction by extension, and then to apply a long outside splint with sufficient extension to abolish the shortening, or to limit it to ½ inch. It is only in a weakly and much-injured patient that it is right to maintain the impaction, for marked lameness is inevitable.

Compound Fractures of the Hip are gunshot injuries.

Separation of the Great Trochanter.—Apart from being a complication of extracapsular fracture, a separation of the epiphysis may happen without displacement. Suppuration has occurred, and death from pyæmia.

Congenital Dislocation of the Hip.

The common term 'congenital dislocation' is often not a correct one. The deformity may be due to a partial or complete absence of the acetabulum, as well as of the head and neck of the femur. In the slightest form there is some deficiency of the rim of the cotyloid cavity and some flattening of the head. It is chiefly seen in female children, and may be unilateral or bilateral. It is liable to be confounded with dislocations which occur during birth, especially in breech presentations, and with those pathological dislocations the result of chronic tubercular disease. The signs are a waddling gait, marked lordosis, and an excessive mobility at the hip-joint, so that the limb can, for instance, be abducted to a right angle with the trunk. When the weight of the body bears on the limb, the great trochanter slips up to the crest of the ilium. In some the deformity causes so little trouble that nothing is required. In others benefit is obtained by long rest, and, in those cases where there is still an acetabulum, by the head being placed in it by manipulation. The patient is anæsthetized, and by extension, circumduction, abduction, and direct pressure, the head of the bone is brought over the acetabulum, into which it slips with a click. If this fails, extension is kept up until the head of the bone is drawn down, and manipulation is again tried. In unfavourable cases, prolonged extension, with abduction, the patient lying in bed, is kept up even for a year or two, and if the joint is very loose, the injection of 10 per cent. chloride of zinc may set up some sclerosis, although complete ankylosis is undesirable.

Attempts have been made to cure the deformity by operation, by fashioning an acetabulum into which the bone is placed and kept there by abducting the limb. The operation is a severe one, entailing the subperiosteal separation of shortened muscles. Even if healing ensues, the result is unsatisfactory, for either ankylosis on the one hand, or relapse to the waddling and lordosis on the other, is the general ending. It is therefore of limited application, and should only be considered when other measures have failed.

It is, nevertheless, an error to assume, because a child is found to have a dislocation about which no history can be obtained, that the head or acetabulum is absent. The success obtained by manipulations for dislocations in young children obliges the surgeon to attempt reduction by manipulation in every case as soon as it is seen, and not to assume the case otherwise until it is proved by the failure under an anæsthetic to get a lodgment of the head in the acetabulum.

Hip-joint Disease.

In its first stages this is a tubercular process, and as such may yield to rest and improvement of health. But pyogenic complications occur, and with this mixed infection the formation of abscesses and ulceration or caries of bone go on.

The disease generally commences in young children, although there may ensue prolonged quiescent periods. It is rare for the disease to show itself for the first time after puberty.

The head of the femur, just beneath the articular cartilage, is usually the site from which the disease spreads to the joint, to the acetabulum, to the capsule, and beyond. It may, however, commence as an epiphysitis of the neck of the femur, so that the first formation of pus is outside the joint.

Acute Form.—The disease may begin acutely with general fever and local inflammation; the child screams with pain whenever the limb is touched; there is fulness over the joint, and very soon an abscess appears.

Subacute Form.—More frequently the disease appears in a subacute form with intermissions, but on the whole steadily advancing. The child limps, puts its hand to its knee, owing to the pain referred from the hip to the terminal ends of the obturator nerve, starts from sleep with a cry of pain, owing to sudden reflex spasm, bringing into contact opposed diseased surfaces, and resists all attempts at movement of the hip, whilst allowing the opposite limb to be freely moved. The limb is held flexed nearly to a right angle, rotated out and adducted, owing to the spasmodic contraction of the psoas and iliacus muscles. This condition becomes more marked, until the limb reaches a right angle and is strongly adducted. The buttock appears flattened and the fold lost at first owing to the flexion, and later the additional wasting of the gluteal muscles. On pressing over the head of the femur pain is experienced, a sense of fulness, or, indeed, actual fluctuation.

Chronic Form.—The early stages of the disease are often ignored by the parents or put down to rheumatism, growing pains, affection of the knee. The patient may then be first seen with marked flexion and adduction, with a fluctuating swelling or suppurating sinus near the hip, or with a pathological (spontaneous) dislocation on to the dorsum ilii, owing to the weakening of the ligaments by the chronic distension of the joint.

Treatment:—Rest, Extension, and Improvement of the General Health.—The child is placed on the back on a hard mattress. Two long outside splints reach from the axilla to beyond the foot, and are united together behind the calf. Extension is made on the diseased limb, and also on the sound limb, if required to keep the child straight. This should be persisted in until all signs of the disease are long past. Very soon the child should be wheeled or be carried into the open air. At first the extension, and later on the splint, may be taken off when going out, but should be reapplied at night.

Incision and Erasion.—Incision and erasion are required whenever pus is forming. This may be clearly diagnosed by the appearance of a fluctuating swelling, or may be inferred by the persistence of a raised temperature, and of pain and fulness over the joint after the application of the splint and extension. The incision is made in the line between the tensor fasciæ femoris and the rectus muscles. After dividing the deep fascia the muscles are well retracted, and if pus is not met with before, the tense capsule over the head of the femur is exposed. The capsule is incised except in those cases where the disease has begun in the epiphysis of the neck and is still outside the joint. After incising the capsule and letting out the contents, the head of the femur is inspected by rotating it; the synovial membrane may be scraped away with small spoons, the interior well swabbed out with an antiseptic, which is afterwards swilled away, and the joint filled with iodoform. Although the whole of the joint cannot be inspected, yet a good deal can be reached by rotating the femur. If the head of the bone is partly carious, the disease may be gouged out, but every effort should be made in an early case to save the head and neck of the bone. The wound may be sewn up with or without a small opening for drainage, and rest and extension continued as before.

Excision.—This treatment becomes necessary to save the patient from amputation and death from exhaustion, but it has the great drawback, that the patient is invariably more or less lame, and it is almost impossible to prevent flexion and adduction from slowly coming on after the patient has begun to walk, and this although the wound has long and soundly healed.

It is an extension of the previous operation; the head is removed by cutting through the neck; the whole of the synovial membrane is scraped away and as much of the acetabulum as is found diseased. Any sinuses or abscess cavities are similarly cleared out. In widespread disease of the femur and pelvis the wound is enlarged by a horizontal incision outwards from the upper end of the vertical one. The cavity is filled with gauze strips, the ends being brought out through the horizontal incision, whilst the rest is sewn up. The gauze is changed daily, until the wound has healed from the bottom. Pain is no doubt caused during the actual dressing of the wound, but this forms the only means of saving the limb, and the pain does not last long if sufficient extension is kept up. It may be alleviated by a small dose of opium beforehand, or by a few whiffs of chloroform carefully given. After the wound has healed, a fixation apparatus, such as Thomas's splint, must be kept on for a year at least, and the foot prevented from touching the ground by a patten fixed under the boot of the sound leg.

Amputation at the Hip for Tubercular Disease.

It is very difficult to decide as to the question of amputation before it is too late, and many children die of exhaustion, of generalized tubercular disease, or of amyloid disease. Its necessity is avoided by the early adoption of the foregoing measures. When there is extensive shortening, grating of the joint-ends, sinuses, etc., excision may be tried; but wide extension of the disease either to the pelvis or upper third of the femur, along with evidence, such as albuminuria or enlargement of the liver and spleen, of commencing amyloid disease, renders an amputation an urgent question. In addition, as much of the acetabulum and ilium as are diseased must be removed. Indeed, the whole of the ilium has been excised at the time of an amputation, and that with success, the periosteum on the venter ilii being preserved intact. The signs of amyloid degeneration may then disappear.

Amputation at the Hip-joint.

This operation is done most frequently for advanced hip-joint disease. It is occasionally performed for myeloid sarcoma of the upper end of the femur, when it may be successful supposing the infiltrated muscles to be also removed. It is the only thing that can be done for periosteal sarcoma of the shaft, but the prognosis is the worst possible.

Primary amputation for injury would come up for consideration in the case of an extensive gunshot wound or crush to the thigh, but it offers no hope of success. In such a case the bleeding should be arrested, the wound cleaned and united in part, and in part packed with gauze. Supposing the patient to rally from the shock of the accident, a secondary amputation may possibly be successful, should gangrene, sloughing, or necrosis supervene.

In amputating at the hip, the first step is to ligature the femoral vessels. A longitudinal incision is made, and the common femoral artery and vein are each firmly tied on the proximal side, temporarily clamped distally, and cut across between the ligature and the clamp.

At the lower end of the longitudinal incision a circular cut is made through the skin and subcutaneous tissue, which is then raised and turned back like a coat-sleeve. This circular division of the skin should be at the junction of the upper and middle thirds of the thigh.

The limb being extended and rotated out, the capsule of the hip-joint is divided transversely, then rotated in for the division of the muscles attached to the great trochanter.

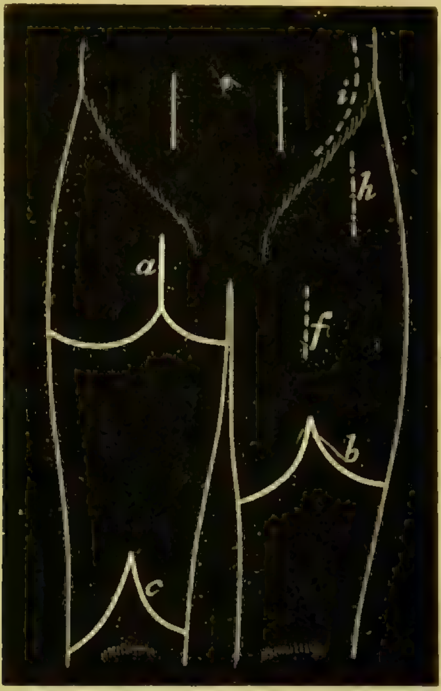

FIG. 102.—OPERATIONS ON THE THIGH.

Lines of incision: *a*, Amputation at hip-joint; *b*, amputation through the middle of the thigh; *c*, amputation through the lower third; *i*, ligature of external iliac artery outside the peritoneum; *f*, ligature of the superficial femoral artery; *h*, incision of the hip-joint extended outwards horizontally.

The limb is now overextended, the knife passed behind the head of the bone, and carried out backwards, dividing the muscles close to the ischial tuberosity.

The only vessels not previously secured are the gluteal branches, which are clamped as soon as divided.

Apart from hæmorrhage, shock occurs when a healthy bone in a young patient is being dislocated from the joint.

Rectangular Ankylosis of the Hip.

The hip-joint, when diseased, naturally becomes flexed to a right angle and adducted. It is at first held in that position by muscular spasm, which can be overcome by gradual and long-continued extension. The joint soon becomes fixed by fibrous adhesions between its joint surfaces, and by shortening of the muscles and ligaments. At first this fibrous ankylosis can be easily overcome without the use of much force when the patient is anæsthetized; but the longer it remains, the firmer the adhesions, which gradually become bony. Meanwhile, owing to disuse, the femur undergoes eccentric atrophy, the compact tissue is reduced to a mere shell, the medullary cavity extends to the end of the shaft. An attempt under these circumstances to break down the rectangular ankylosis may result in fracture through the upper third of the femur. Fatal results have attended such forcible fractures, either from shock, fat embolism, or suppuration and pyæmia.

A limb is prevented from becoming fixed in this position by the treatment above described. Being so fixed, it may remain throughout life without giving rise to further inflammation. The patient walks with a cork sole on the boot, of such a height that too much weight is not thrown on the sound limb, and lateral curvature provoked. The flexed and adducted hip may give rise to difficulties in connection with marriage or child-bearing. The tubercular disease may be lighted up again by a chance blow or strain, by overwork or feeble health. When bilateral the legs are crossed (' scissor legs '), and the patient cannot walk.

Osteotomy of the Femur.

It is generally best to let an ankylosed hip alone. When, however, it is a continuous source of pain, and prevents the patient from following an occupation, and especially when bilateral, the neck of the femur may be cut through by making a short incision just above the great trochanter, and introducing through it a chisel or keyhole saw. In case the head and neck have been destroyed, the bone may be cut through by making an external puncture just below the trochanter. The chisel or saw must not be driven beyond the inner margin of the bone, for fear of wounding the vessels. After dividing the bone, the limb is extended and fixed in this position until union at the site of division has ensued. A transverse incision can also be made, bands are divided, and if the hip cannot then be extended, the neck can be cut through, guided by the eye.

Ruptures of Muscles.

The adductor muscles may be ruptured in riding, the vasti and rectus at football, the quadriceps extensor tendon in old men instead of the patella giving way. In most cases the rupture is attributed to overaction in a patient whose muscular tone is not good. The accident is especially indicated by the gap in the muscle, accompanied by pain, inability to move, and ecchymoses from the extravasation of blood.

Rest with massage is the general treatment. This cannot be expected to do any good if the muscle has been entirely or nearly torn across. In suitable cases an incision is made, and the ruptured ends sutured. This applies especially to such a tendon as the quadriceps extensor, unless the patient be too old.

Fractures of the Shaft of the Femur.

The commonest site for fracture is in the middle third. Direct violence is the general cause. Fractures just above the condyles may be due to indirect violence, falls on the knee; on the other hand, fractures in the upper third are only from direct violence.

Fracture about the Middle of the Shaft is common in children, *e.g.*, from falls in which the thigh is doubled under the body; in them the fracture may be transverse without marked displacement. In adults the fracture is more or less oblique, and the lower fragment is pulled upwards and inwards, whilst the upper fragment is tipped forwards and a little outwards. The shortening in such cases may vary from 1 inch up to 4 inches. Spiral, comminuted, and open fractures are all rare, and attend severe and fatal injuries.

Reduction is made by extension. This may be easily done immediately, especially under anæsthesia; later on there is greater difficulty, as the muscles recover their tone. If union takes place, with shortening beyond $\frac{1}{2}$ to $\frac{3}{4}$ inch, the patient is lamed for life, and the femur is never strong. It is absolutely necessary, therefore, to apply sufficient extension to bring the ruptured leg to the same length as the other, or at least within ½ inch. In a day or two, as the muscles recover, the extension may become insufficient. It is necessary, therefore, to measure a fractured limb daily, so as to avoid the insidious recurrence of shortening.

A fracture of the femur is best treated by an outside straight splint, and extension applied to the leg by strapping. The foot of the bed is tipped sufficiently to obtain counter-extension, or this may be made over the head of the bed by a band under the shoulders. It is possible to apply as much as 30 lb. to a limb in the case of a neglected fracture without disturbing the fracture. The bed-pan can be inserted by the patient flexing the sound leg, and so raising his pelvis a little.

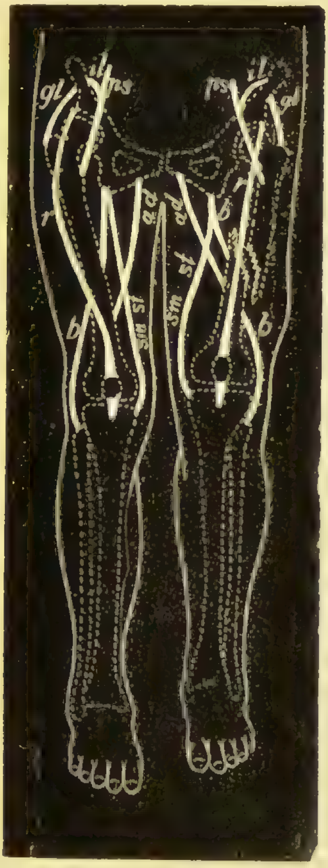

FIG. 103.—FRACTURE OF THE SHAFT OF THE FEMUR.

On the left side is shown the displacement of the lower fragment upwards, inwards, and backwards by muscular action. Muscles: *ps*, psoas; *il*, iliacus; *gl*, gluteus; *r*, rectus; *ad*, adductor; *b*, biceps; *sm st*, semi-membranosus and semi-tendinosus muscles.

In the case of children, it is best to apply a second splint on the sound limb, and unite them by a cross-piece behind the legs. This prevents wriggling, and allows the patient to be turned and cleaned by the nurse without disturbing the fracture.

Malunion, with more or less shortening, occurs when too little extension has been made, or when the patient has been got up early in a plaster of Paris bandage. This may be rectified under an anæsthetic before the union has become firm.

Vertical Extension for Young Children and Infants.—Extension is applied to both legs, and the cords are fixed vertically above the child. The extension should be just enough to raise the buttocks from the bed. Infants and young children stay quietly in this position, and can be easily kept clean. The legs must be well wrapped up.

Fracture through the Lower Third, just above the Condyles.—When due to indirect violence, falls on the feet or knee, the line of fracture is obliquely downwards and forwards. The lower end of the upper fragment may pierce the quadriceps extensor, and appear beneath the skin, or perforate the skin just above the patella, with or without perforating the joint. At the same time the lower fragment tends to be tilted back by the unopposed action of the gastrocnemius. As a further complication, the popliteal artery and vein may be ruptured, and a diffused traumatic aneurysm and gangrene be the result.

The fracture is treated by a straight splint and extension. As a preventive to the tilting back of the lower fragment, the tendo Achillis is divided by a tenotome. This is a valuable method, if the knee be severely injured, for ankylosis can then be obtained in the extended position. When, however, the fracture is in the lower third, and the knee-joint not injured, the limb may be placed on a double inclined plane, or slung in an anterior wire splint. Passive movement of the knee-joint must be done as early as possible, to avoid ankylosis in a flexed position.

A compound fracture is replaced after cleaning the projecting fragments. If the knee-joint be injured, it will require incision and washing out of clot. In this case the limb must be treated in the extended position. Injury to the popliteal artery may entail the complete arrest of the circulation in the limb below. If the limb be found absolutely cold, an incision must be made at once into the popliteal space, and the clots turned out, and the injury to the artery and vein secured.

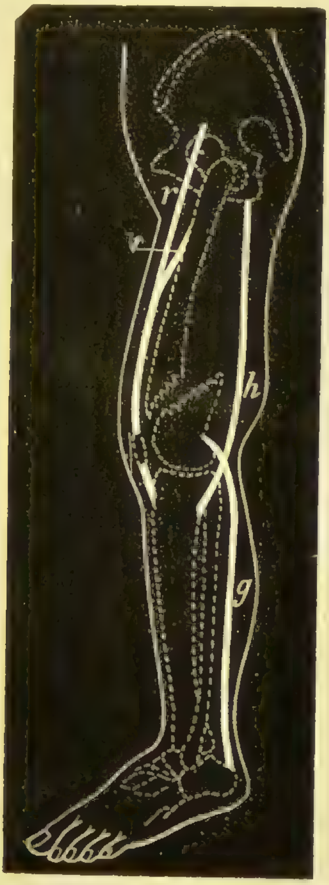

FIG. 104.—FRACTURE THROUGH THE LOWER THIRD OF THE FEMUR.

r, *v*, Quadriceps extenso[illegible]nd *h*, hamstring muscles, drawing upwards the lower fragment beh[illegible]e upper; *g*, gastrocnemius muscle rotating lower end of femur back[illegible]

The re[illegible]ressure of the clot may allow of sufficient [illegible]ing circulation through the articular arteries. But the case must be watched, and if the limb remains cold, and gangrene threatens to set in, amputation just above the site of fracture is necessary. The anastomotic circulation is not good, because the blood must pass through two sets of capillaries, from the profunda or anastomotic into the articular, and from the articular into the tibial vessels. Yet recovery has followed the ligature of both artery and vein.

If a circumscribed aneurysm forms, its treatment may be delayed until the fracture has united.

Fracture of the Condyles.—Owing to direct violence, there is caused a T-shaped fracture involving the joint. The condyles will move on the femur and on one another, or one condyle may be knocked off, the other remaining attached to the femur. In either case, passive movement must be begun early, so as to prevent ankylosis. Care must also be taken that the limb is kept straight, so that neither knock-knee nor bow-leg results.

Separation of the Lower Epiphysis.—This is a severe accident which happens in a boy just before or about puberty. The knee-joint may be freely opened, and blood extravasated into it, the periosteum may be widely torn up, and there may be danger of suppuration and necrosis, or of injury to the popliteal vessels. It is treated with the knee in the extended position. Severe accidents have needed amputation.

Non-union and Delayed Union, if it takes place in a healthy person, must be ascribed to incomplete rest and extension, which must therefore be reapplied.

Malunion may occur with much shortening—*e.g.*, 4 inches: the limb is bowed, weak, painful, and the patient very lame. If in good health, the patient should be submitted to osteotomy, the fracture divided, and complete extension made. It is in such cases that weights from 20 to 30 pounds may be required to fully extend the limb.

Non-union may be treated by rubbing the ends together, by injecting 10 per cent. chloride of zinc, or by resecting the ends and wiring them together. The latter is an important operation, absolutely dependent upon careful antisepsis.

Exostosis.

It grows from the lower epiphysis, and forms a tumour on the inner side, which, as the patient grows, may get shifted up as high as the middle third by the lengthening of the diaphysis. It is pedunculated, mushroom-shaped, covered by a layer of cartilage and a bursa, which may be distended with fluid. It is a cause of pain, it may be fractured and become loose, or set up suppuration and ulceration of the skin.

When growing posteriorly, it may come in contact with the popliteal artery, and cause an aneurysm.

The pedunculated form is easily removed by a chisel or saw.

A sessile form of exostosis occurs as the result of rickets, may be multiple, and is liable to become sarcoma. Early exploration and removal are indicated.

Malignant Disease of the Femur.

Myeloid Sarcoma is most common at the lower end of the femur, but it may occur at the upper end. It is sometimes directly connected with an injury. After excluding a gumma, it may be diagnosed by its relatively slow growth and by its position. On incision, it will exhibit a shell separating the tumour from adjacent muscles, and the section of the tumour appears of a maroon colour, or is cystic, and contains blood-clot. If amputation be done so as to remove the growth before it has infiltrated the muscles, a cure may be expected, also the disease does not spread up the marrow cavity. If operation is too long delayed, spontaneous fracture may occur.

Periosteal Sarcoma.—This growth arises in the middle of the shaft, but also at the upper or lower end. It is equally malignant whether the tumour is soft and brain-like, or consists largely of cartilage or bone. It spreads by infiltrating the muscles and along the lymphatics to the glands within three or four months of the apparent origin of the growth.

A rapidly-growing tumour, especially in a young adult, must first be distinguished from an acquired or inherited gumma by the absence of diminution during ten days or a fortnight under full doses of iodide of potassium and mercury. An exploratory incision will distinguish the growth from a case of quiet necrosis, and from a myeloid sarcoma when near the lower end of the femur. A periosteal sarcoma having been found, amputation at the hip-joint, and removal of all the lymphatic glands of the groin, offers the only prospect of cure. If a true periosteal sarcoma, secondary growths will almost certainly have occurred within three or four months—*e.g.*, enlargement of lumbar glands, enlargement of the liver with cachexia, scattered growths on the surface of the lungs, with hæmorrhagic pleural effusion.

In cases which are 'cured' by amputation, the 'sarcoma' removed generally proves on microscopic examination to be a myeloid, or a gumma, or of inflammatory origin, either quiet necrosis, a callus tumour, or a hydatid.

Septic Inflammation of the Femur.

The disease generally commences as an epiphysitis, and attacks the diaphyseal end of the shaft. The acute and subacute affections are due to pyogenic organisms. This may also be the case with chronic forms, but tuberculosis or syphilis must be added to the list of causes.

Acute Septic Inflammation commences generally about the epiphysis, and is particularly common in boys approaching puberty, when the growing end of the bone is very vascular. Following or not upon a slight injury, the patient is attacked by a fever, with obscure pain, or there is, in addition, swelling just above the knee. Granted a well-marked fever, as indicated by a temperature of 102° F., and some delirium at night, a longitudinal incision should at once be made down to the epiphysis on the inner or outer side, without waiting for fluctuating. Pus is found beneath the periosteum, or only after boring into the bone. If even but little pus be yet formed, the periosteum will be found swollen, and the bone soft, and pyogenic organisms can be obtained from the bloody fluid exuding.

In an acute case, within two to three days of the commencement, pus will extend to the vein, and cause a septic thrombus, from which emboli are carried to the lungs. The patient may now exhibit rigors, have a rapid pulse of diminishing tension, continuous delirium, a brown and shrunken tongue. Amputation above the disease must immediately be done. The patient may die of the operation, owing to the delay until the pulse has become weak, or may die shortly of septic pneumonia, due to emboli carried to the lung before the operation. If the patient lives, he must be constantly examined from head to foot for pyæmic collections of oily pus in the joints or subcutaneous tissue. When the patient has lived long enough for a metastatic abscess to be opened, the prognosis is improved.

Subacute Inflammation.--The disease is less acute in its onset ; extensive necrosis of the lower part of the femur takes place, and sinuses form. All the bare bone must be exposed, and the dead part chiselled away. If the medullary cavity is involved, a longitudinal channel is cut into it, and its contents cleared out. In one case the whole length of the medullary cavity of the femur was exposed through an external incision, and scraped out with success, so that amputation was avoided. The cavity left is dressed daily with gauze, so that it can heal from the bottom.

A neglected disease of the lower end of the femur may spread to the knee-joint. A sequestrum may be displaced, and ulcerate into the popliteal artery.

Chronic Inflammation—Quiet Necrosis—Necrosis without Suppuration.—This is a localized condition started by tubercle, syphilis, a blow, or pyogenic organisms. The exudation and the necrosed bone is slowly absorbed. Meanwhile a smooth-walled cavity is left, around which chronic inflammation goes on. This may be indicated simply by pain of an intermittent character, or by a slowly-increasing tumour, owing to the progressive sclerosis of the surrounding tissues. It is liable to be mistaken for a gumma—indeed, temporary relief may be given by administering iodide of potassium, due either to the diminution of the circulation through the part, or owing to the fact that syphilis was the primary cause. Or it may be mistaken for a slow-growing myeloid sarcoma. Spontaneous fracture may occur, or inflammatory disease may later on be complicated by sarcoma.

Early exploratory incision is the one treatment. If inflammatory, the cavity is scraped out, and necrosed bone removed. Even when a fracture has happened, if a new growth be absent, and the patient young, resection and the opposition of healthy fragments may be followed by union.

Amputation through the Femur.

This is frequently done through or just above the condyles. The especial advantage is that the medullary cavity is not opened to an extension of suppuration. This was of greater importance formerly.

Amputations through the middle and lower thirds are comparatively safe operations; amputation through the upper third is less commonly required, and it is practically as important an operation as that through the hip-joint, and no apparatus can be fixed to the stump. It has not the advantage of that at the hip-joint in removing the whole bone when affected with sarcoma, necrosis, etc.

Amputation through the thigh at any level can be done by lateral flaps, the combined length of the two flaps being twice the diameter of the limb at the point of cutting off the bone. This length is necessary on account of the muscle, and at the level of the condyles the broad end of the bone has to be covered in. It is most important to avoid a pointed stump arising from too short flaps. The flaps do not take up any muscle. The femoral artery and vein are tied first before releasing the band; branches of the profunda in the muscles close to the bone, and the artery accompanying the sciatic nerve, also require ligatures. The sciatic nerve must be pulled out and cut as short as possible. A drain is inserted at the end of the incision behind. The scar will be gradually drawn backwards and upwards, so that the end of the bone does not bear upon it.

Instead of lateral flaps, antero-posterior flaps may be employed, the posterior flap being rather shorter than the anterior, neither including muscle.

An artificial limb can be worn with advantage when the amputation is below the middle of the shaft. Above this, as well as in the case of the hip-joint, the patient can only use a crutch.

CHAPTER XLI.

SURGERY OF THE KNEE AND POPLITEAL SPACE.

Fracture of the Patella.

The common fracture is transverse, due to muscular violence in the attempt to save the body from falling; the previous fracture of one patella, by weakening the limb, may predispose to the fracture of the other. Direct fractures of the patella may be vertical, comminuted in a starred direction, also compound; they are comparatively rare, and are important only as endangering the knee.

The common transverse fracture is difficult to treat, according to the amount of tearing of the aponeurosis of the quadriceps extensor, and the consequent separation of the fragments. There may be scarcely any separation, or 1 to 2 fingers' breadth may separate the ends, or the upper fragment may be completely torn away from the lower, and drawn up 4 to 6 inches.

The diagnosis presents no difficulty immediately after the accident. If much effusion into the knee and swelling around has already supervened, it may be difficult to feel the fragments or to get crepitus between them. If there is much fluid in the joint, it may be drawn off by a fine aspirating needle, and so allow of a diagnosis. If the swelling is chiefly in the subcutaneous tissue around the joint, there may be delay before the fracture can be diagnosed, unless the patient is anæsthetized. Whenever the fragments are in apposition, union takes place firmly by bone, whether the apposition result from the fact that there never has been separation, and the aponeurosis is intact, or because the fragments have been brought again into apposition. If, however, the fragments are separated by less than a finger's breadth, the gap has the form of a **V**, the angle of which is directed towards the joint, fibrous tissue fills up the gap, and the union will be quite satisfactory. If, however, the separation is greater, the limb is left weak; this is not so much due to the fact that the fibrous band uniting the fragments is not strong, but to the shortening of the quadriceps extensor. The muscle is not kept tense, and therefore loses a greater part of its power, and there is a corresponding loss of power in the opposing flexor muscles. A man in whom the fragments are separated by a couple of fingers' breadth or more cannot carry a weight upstairs or up a ladder; indeed, he has to plant his foot sideways, and haul himself up by his hands on the rail. A patient in whom there is 3 to 6 inches' separation has a leg practically paralyzed; he can only swing it by the hip muscles; he cannot raise his toes nor exert his flexor muscles, all because the quadriceps is so short that it cannot contract co-ordinately with the other muscles.

If there is no separation or it is less than a finger's breadth, the limb is kept straight in bed and cold lotions are applied. As soon as the swelling has subsided, passive movement is begun, so as to prevent limitation of movements of the knee.

If the fragments are more widely separated, but there is no effusion as yet in the knee, and the fragments can be easily brought together, they are held by the fingers and thumb of an assistant, whilst a plaster of Paris bandage is applied. The joint should be covered by a layer of wool, then a flannel bandage is carried from the ankle to the great trochanter, and over this the plaster of Paris bandage: in making the turns round the knee the fragments can be drawn together. The bandage with the wool beneath will keep up pressure and prevent exudation. After two days a window is cut in the plaster over the patella and the fragments examined. If in position the plaster is kept on for a month to five weeks, then removed, and movements of the knee encouraged to prevent fixation. The patient must avoid bearing weight on the bent knee for six months, and for that purpose it is kept straight most of the day by a leather or other splint, which is taken off only to exercise the knee. If, however, on cutting open the window a gap of more than a finger's breadth be found, this method of treatment should be abandoned.

The plaster of Paris cannot be used if swelling from effusion is already present. Instead of plaster a back-splint may be applied, and the fragments drawn together by strips of strapping or by pieces of elastic bandage. But the same limitations apply to the splint as to the plaster; it is of no service when swelling is already present, and this plan must be abandoned whenever there is separation of the fragments, except in aged people.

Primary Suture of Fractured Patella.

Whenever the separation is greater than a finger's breadth, some one of the methods must be adopted for uniting the fragments, the only exception being in the case of aged people.

Union of the Fragments by an Antero-Posterior Loop of Silver Wire (Barker's Method).—The success of the operation depends entirely upon the antiseptic precautions. The patient being anæsthetized, a puncture is made into the joint through the ligamentum patellæ with a scalpel, and all blood-clot squeezed out of the joint. Then a strong curved needle on a handle is passed through the puncture behind the fragments of the patella, through the quadriceps tendon immediately above the upper fragment, and then through a nick in the skin. One end of thick soft wire, or the ends of two strands of less thick wire are passed through the eye and the needle withdrawn. The empty needle is again passed, but this time in front of the patella fragments, and the other end or ends of the wire carried back in front of the patella. The wire suture is then twisted up, whilst the fragments are held together, the free ends cut off, and the twisted ends hammered inwards towards the bone. The small wounds are covered, and passive movement is begun on the next day or the day after, and within a week the patient may sit on the side of the bed and swing his leg at the knee.

As soon as the punctures have healed, the patient may walk, go upstairs, etc.; at the end of ten weeks a case has been able to hop well on the leg.

The advantages of this method are that, owing to the removal of the blood-clot and the early movement, there is no tendency to fixation of the knee-joint, and the patella cannot stick to the condyles. There is no wide opening of the joint, yet the wire includes the fragments so firmly that the patient can use his limb in any way as soon as the punctures have healed. With the most successful of the other methods the patient has to keep his knee stiff, or to avoid putting any great weight on it for six months, for fear that the line of union may stretch, and this is time lost.

Secondary Suture of an Ununited Patella.

The indication for this operation is the inability of the patient to use the limb on account of the want of power in the quadriceps, and the corresponding weakness of the opposing flexor muscles. A flap of skin is raised by a semilunar incision, in order to avoid contact of the sutures in the patella with the skin wound, or a transverse incision may be made. The fractured edges are refreshed by a knife or saw, and the fragments united by one or two loops of silver wire, as described for the primary suture. If the ends do not come easily together, the limb is flexed at the hip, and if this is not enough, the quadriceps extensor tendon is partly divided or advanced (see Fig. 51 C, p. 107); the muscle at the sides partly stretches. Even if a stiff knee ensues, the patient regains the use of his flexor muscles, and is able to raise himself on his toes, etc. When possible, movement of the joint is obtained.

Dislocations of the Patella.

The outward dislocation, which is the commonest, is predisposed to by knock-knee, the inward dislocation by bow-leg. In some there is an excessive relaxation of the ligamentum patellæ. The dislocation may in such cases be the result of muscular violence. Direct violence may also cause a dislocation. The patella may lie on the front of either condyle, or be completely dislocated on to the outer or inner surface. It may also be tilted, and one edge be fixed in the notch between the condyles, the so-called version of the patella. The knee is fixed in slight flexion, and the displaced patella is easily felt.

The patella is reduced by pressure with the thumb and finger, combined with relaxation of the quadriceps, by flexing the hip or by means of an anæsthetic. The predisposing agencies must be treated in order to avoid recurrence.

Rupture of the Ligamentum Patellæ.—Instead of a fracture of the patella, the ligament is occasionally torn across and the patella drawn upwards.

Rupture of the Quadriceps Extensor Tendon.—This is also a rare variety, and is indicated by the weakness of the limb and the gap above the patella. Both these accidents are unsatisfactory when treated by rest in the extended position, unless the rupture is partial. Therefore it is generally best to suture the ruptured muscle or tendon immediately after the accident.

Dislocations of the Knee.

Complete dislocations are very rare, and partial ones are not common, for even for the latter there must be sufficient force to tear the ligaments. The general injuries are confined to the synovial membrane and interarticular cartilages. Complete dislocations have occurred from the knee being forcibly moved while the femur was fixed—*e.g.*, whilst shifting iron girders, or from stepping between the joists of an unfloored room.

The dislocation may be lateral, with rupture of the lateral and crucial ligaments, or forwards with stretching of the ligamentum patellæ, or backwards with tearing of the posterior ligament, dislocation of the interarticular cartilages, and pressure upon, or laceration of, the popliteal vessels and nerves.

Extension and manipulation obtain reduction, after which passive movement has to be kept up.

Internal Injuries of the Knee-Joint—Sprains of the Knee—Dislocation of the Interarticular Cartilage—Separation of Pieces of Articular Cartilage.

A violent strain may rupture a fold of synovial membrane, and this is followed by effusion of blood, acute, and subsequently chronic, synovitis, with loose fibrinous bodies in the joint.

A dislocation of an interarticular cartilage—generally the internal one—produces locking, or allows only very limited and painful movement in the joint along with traumatic synovitis. It is caused especially by strong twists.

Separation of a piece of cartilage is due to a fall against a sharp object, or the knee may be struck. Acute synovitis is set up, and after this has become chronic a loose body is found in the joint, which at times slips between the cartilaginous ends and causes great pain and locking. The locking is, however, intermittent, the loose cartilage forming a cavity for itself, out of which it slips and to which it returns.

The sprains are treated by rest and cold applications: ice, spirit, and lead lotions; later on, mercurial ointment. Cold douches, massage, and gentle movements, are of service. If fibrinous bodies form, and chronic synovitis and effusion continue, and the bodies are felt moving in the joint, they must be removed by washing out through an incision.

Dislocation of a cartilage is reduced by flexion and extension under an anæsthetic. If this does not succeed, the cartilage is cut down upon and stitched in position to the periosteum of the tibia, or, when altered by the injury or subsequent inflammation, removed. If, after once being reduced, the accident recurs, a favourable opportunity, when there is little inflammation, should be seized for fixing the cartilage.

A loose body can often be felt on one or other side of the patella. If so, it can be transfixed by a strong needle, cut down upon and removed, or a longitudinal incision is made to one or other side of the patella, the body seized by forceps, and the joint afterwards washed out.

It is generally best to unite incisions, but to allow of drainage for a day or two after chronic effusions. Passive movement is begun early.

Punctured Wound of the Knee-Joint.

This is of importance on account of the danger of retention of pus in the joint causing septic infection and destruction of the knee, rendering amputation the only means of saving life.

A punctured wound in the neighbourhood of the knee is washed, squeezed, and then a probe passed. If this enters the knee, and if the puncture has been made by a septic instrument, it is best to make an incision an inch long to one or other side of the patella, and wash out the joint most thoroughly, after which the limb is placed on a splint, and the incision left open for any exudation to escape.

A doubtful case of penetration is watched for any septic effusion into the knee, at the first sign of which the joint is incised and washed out. In a neglected case there is severe general and local inflammation; pressure on the knee may cause pus to be squeezed through the puncture. A freer opening will be necessary, *e.g.*, two incisions, one on either side of the patella, some 2 inches in length; then by wiping and scraping all septic matter is removed. The knee must be kept at rest until all inflammation has ceased, and a prolonged fixation may be required, or even permanent ankylosis, when the ligaments have been weakened. Any extension of the suppuration outside the joint is treated, immediately it is found, by free incision, and the filling of the abscess cavities with gauze.

Gunshot and Incised Wounds of the Knee.

The whole joint is cleaned, comminuted fragments of bone are replaced, the wound is united, except for a drain, which is left in for two days, until danger from collection of exudation has ceased.

Until the Russo-Turkish war of 1877, when thorough Listerian methods were first applied, amputation had been the rule for all wounds of the knee-joint. Before that, especially in war, the expectant treatment had always ended fatally.

Inflammation of the Knee-Joint.

The signs are redness and heat, pain, collection of fluid in the joint, thickening of the synovial membrane, changes in the ends of the bones, and wasting of the muscles.

Heat and redness may be very marked in acute inflammation, but absent in other cases, *e.g.*, pyæmic or tubercular suppuration. The joint is always hotter; it may be the only sign of chronic inflammation. Both knees are exposed to the air for a minute or two, and then the palm of the hand is applied. The skin covering the patella of the normal knee strikes cold, whilst this sensation of cold is not felt over the other knee, however chronic the inflammation.

Pain may be felt in the ligaments, especially the lateral ligaments, and is then made worse by putting the ligament on the stretch, or by pressing on it. The pain may be due to excessive distension of the synovial membrane, and is relieved when some of this fluid is drawn off. The contact of the joint surfaces may be the cause of the pain; movement of flexion and extension is then resisted, on account of the pain occasioned. The pain may be due to the collection of pus in the head of the tibia or femur, or, indeed, from chronic osteitis in which pus has not yet formed. The pain is then worse when the limb is warm in bed, and especially upon firm pressure on certain points of the bone.

Fluid.—The synovial membrane becomes distended and bulged upwards beneath the quadriceps. A small collection of fluid causes the depressions on either side of the patella to be lost. By making pressure with one thumb and finger placed on either side of the ligament, and the other thumb and finger above the patella, fluctuation may be obtained. By pushing with the palms all the fluid together underneath the patella, this bone is floated forwards; sharp pressure on it backwards then causes it to tap the femur. Serous fluid and pus may be distinguished by considerations as to the origin, by the amount of the general and local inflammation, and in a doubtful case by drawing off, with an aspirating syringe, a little of the fluid. This measure will, moreover, show the presence of blood in the joint.

Serous fluid in a joint may result from injury, from rheumatism, or in patients suffering from locomotor ataxia (Charcot's disease). It may also be due to syphilis, gonorrhœa, or tubercle. Syphilitic hydrarthrosis occurs in the secondary stage, and yields to mercury and iodide of potassium. Gonorrhœal synovitis is the result of a chronic gleet, with or without a tendency to stricture. Tubercular hydrarthrosis may supervene upon a chronic synovitis, and is indicated by its persistence, by the increasing thickness of the synovial membrane, and may also be proved by inoculation experiments made with the fluid drawn off.

Pus may collect in the knee-joint owing to a septic wound, or by direct extension from the adjacent bone. It may be the result of any kind of pyæmia, including gonorrhœa. In a typical case of pyæmia, pus rapidly collects in the joint without much sign of inflammation, and the pus has a characteristically thin and oily consistence. When due to gonorrhœa, there is often much pain, thickening of the synovial membrane, with the collection of a comparatively small amount of fibrinous pus in the joint, but with much periarthritis. The pus originating in the course of tubercular disease varies according to the amount of mixed infection with pyogenic cocci.

Blood in the knee-joint comes from the synovial membrane torn by an injury. Occasionally it complicates rheumatic synovitis in bleeders. The other causes are a fracture, sarcoma, or popliteal aneurysm extending into the joint. The presence of blood is shown by aspirating some off, and altered blood pigment may appear later subcutaneously.

Thickening of the Synovial Membrane obscuring the bony prominences is most commonly tubercular, less often gonorrhœal, in origin, more rarely the result of chronic rheumatism, of syphilitic gummatous inflammation, or even of sarcoma.

Changes in the Ends of the Bones.—In chronic rheumatism and gout, the cartilages become rough, fibrillated, and wear away, so that slight creaking, grating, or audible crackling occurs, with limitation of movement. As the disease goes on, the diminution of movement is more marked, with deformity of the ends of the bone, owing to bone formation at the attachment of the synovial membrane and ligaments.

In Charcot's disease, the wearing away of the bone and the deformity of the ends are great. There is often increased mobility, including lateral movements, but the joint may also become fixed by the excessive bone formation, "lipping," around.

Ulceration or caries of the bone is usually the result of tubercular disease, which, commencing by the formation of tubercles just beneath the articular cartilage or at the line of the epiphysis, causes progressive destruction of the end of the bone. The special signs are fever and continuous pain, made much worse by the slightest movement. The ligaments become inflamed and relaxed, so that the joint is flexed, the head of the tibia drawn backwards, and rotated outwards by the ham-strings. Abscesses form outside the joint, which burst and give rise to sinuses. The disease may then go on faster from the introduction of further septic infection, or, less often, healing may ensue with the joint in a flexed and useless position.

Septic suppuration in the knee, traumatic, gonorrhœal, etc., in origin, if not immediately stopped, causes rapid destruction of the ends of the bone. Septic thrombi form in the popliteal vein, and are carried to the lungs, or suppuration spreads upwards amongst the muscles of the thigh. Then amputation offers the only hope of saving life.

The Treatment of Disease of the Knee-Joint.

Acute inflammation is treated by rest, cold lotions, and ice. Pain is relieved by application of extract of belladonna in glycerine, or by hot fomentations, with the addition of opium tincture. Chronic inflammation is treated by a back-splint and mercury ointment, or iodine liniment frequently painted on, or by fixing the joint in a plaster or silicate bandage, or other apparatus. A child with a tubercular knee requires tonics and cod-liver-oil, but above all, good food and fresh air.

Aspiration of the Knee.

This may be done for the relief of tension. The joint should afterwards be surrounded by wool, and a firm bandage applied, so as to prevent a recurrence of the exudation, always supposing that there is no sign of suppuration. An examination of the fluid is important for diagnosis.

Incision of the Joint.

This is immediately necessary whenever pus has formed. The joint is thoroughly washed and sponged out, and then drained. A longitudinal incision about 2 inches long is made over the internal condyle to the inner side of the patella. A similar incision can be made over the outer condyle if needed. If extension has already taken place backwards, a counter-opening is made in the popliteal space by pushing backwards dressing forceps between the vessels and nerves, and a drain inserted.

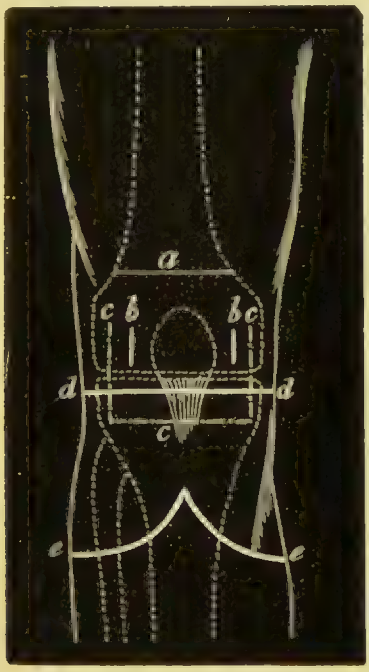

FIG. 105.—OPERATIONS ABOUT THE KNEE.

a, Line of division of the femur for knock-knee; *b*, *b*, line of incisions for drainage of knee; *c*, line of incision for arthrectomy; *d*, line of incision for excision of knee-joint; *e*, *e*, line of incision for amputation through the upper third of leg.

A small incision may be made for chronic hydrarthrosis, and then fibrinous masses, the result of previous inflammation, may be washed out. The wound is either sutured or drained, and the joint firmly bandaged.

Partial Excision or Arthrectomy of the Knee-Joint.

This consists in removing the whole of the synovial membrane, and is generally employed against tubercular disease, although exceptionally for the removal of synovial membrane thickened by gummatous or chronic rheumatic inflammation.

An elastic band is placed round the thigh, and a small incision first made, so that the joint can be explored. If the diagnosis is confirmed, a rectangular incision is completed, so as to turn up as a flap the anterior covering of the joint. In doing so, the patella must be cut across, or the ligament divided, or the tuberosity cut off from the tibia with a chisel —the latter being the preferable method. In turning up the flap, the lateral incisions may be extended so as to allow of all pockets beneath the quadriceps extensor tendon being reached. The synovial membrane is completely dissected or scraped away, the crucial and semilunar cartilages removed, and the anterior surface of the ligament of Winslow scraped. All diseased bone is gouged out. The pockets in the neighbourhood of the joint are laid open, cleared out, and filled with gauze. The rubber band is not removed until after the application of the bandage. Thus, there is no loss of blood during the operation, which is important in a weakly child, and there is no oozing into the joint cavity. Drains may be inserted at the most dependent angles, or buttonhole openings for the insertion of drain may be made from the deepest part of the pockets, or the joint may be drained from behind through the popliteal space. Even when there is extensive bone disease, this is now generally removed by gouges, rather than by transverse cutting with the saw, except in those who have reached puberty.

The advantage of arthrectomy over excision is that the epiphyseal line is left uninjured in young subjects, thus allowing of further growth. Even if an epiphyseal line be partly involved, yet the remainder may be healthy. Again, in arthrectomy the lateral ligaments are not divided, and therefore ankylosis is more likely, and there is less tendency to displacement backwards.

Tubercular disease in a young subject should never be allowed to extend further than what can be cured by arthrectomy. If, however, this be the case, it is unlikely that before puberty excision will be so useful as amputation.

Excision of the Knee.

This operation is now generally confined to adults. It is suitable for a case of tubercular disease which has already reached puberty, in which the disease is still confined to the joint and to the ends of the bone, but in which there is as yet no extension of the suppuration. In such a case the application of two healthy cut surfaces will end in a firmly-ankylosed limb, but after middle life this power of repair fails.

The usual incision is a rectangular flap. The patella may be raised in this, or, if diseased, removed. After dividing the lateral ligaments, the joint is well flexed, and the ends of the bones cut off, so as to remove the whole of the joint surfaces, the section of each bone being made exactly in a horizontal plane. Thus the cut ends of the bone will come into accurate apposition, and may be left, held by a plaster bandage only, or sutured by wire or pegged with ivory pins in addition. The plaster of Paris is afterwards partly cut away, so as to dress the wound. The plaster can be stiffened behind by inserting a splint between its layers.

If pockets have formed requiring drainage, the limb has to be kept on a back-splint, with or without extension, and the worst parts filled daily with iodoform gauze. If suppuration continues after the operation, there will be a tendency to dislocation backwards and rotation outward. This will be the more marked if this tendency has existed beforehand. An attempt to overcome the dislocation backwards by tenotomy is not likely to be successful. Such a knee will be less useful than a stump after amputation.

Ankylosis of the Knee.

When recent and fibrous, it is a question whether, free movement being made, it will be afterwards sustained, or whether further inflammation and adhesions will be set up. A slightly bent knee may be straightened by gradual extension, either by weight and strapping, or by placing sand-bags across the bent knee.

The forcible movement of a knee-joint which has been ankylosed for some time is a serious matter. There may be severe shock, or fracture from the previous eccentric atrophy consequent on disuse; fat embolism takes place from fat liberated from the spaces of the atrophied bone, getting into the circulation and lodging in the capillaries of the lung. The vessels and nerves in the popliteal space gradually shorten when the knee is continuously flexed; they ultimately lose the power of stretching, and rupture occurs when the knee is straightened. It is generally safer either to divide adhesions through an open incision or to excise the joint by the removal of a wedge-shaped mass, so as to leave the cut surfaces of the bones horizontal and suitable for apposition. This operation is more clearly indicated when the ankylosis of the knee is accompanied by displacement of the tibia backwards.

Contraction of the Hamstring Tendons.

The contracted tendon is exposed through a small incision, drawn forward by a hook into view in order to distinguish it from a nerve, and then divided. Subcutaneous operations are dangerous; the external popliteal nerve may be mistaken for the biceps tendon.

Knock-knee and Bow-leg—Genu Varum and Genu Valgum.

The femur and tibia are bent by the weight of the body when the child begins to walk, if ossification is delayed by rickets.

In knock-knee the femur and tibia form a **S**-like curve. bending outward in the upper part, and inwards below. The result is excessive pressure and diminished growth on the outer side. The leg is deviated outwards, and the line of the knee in the upright position is no longer horizontal, being lower on the inner side and higher on the outer. The condition is aggravated by the stretching of the internal lateral ligament, and by the development of flat-foot.

In bow-leg the femur and tibia form one external curve, the growth on the inner side being checked, that on the outer continuing, and the external lateral ligament stretching. Bow-leg is complicated by rotation out of the femur, so that the head of the femur becomes altered.

In both knock-kneed and bow-legged children there is a great tendency to return to the straight line if they can be kept on their backs in bed for a year or two. The parents, however, find it difficult to keep children in bed on their backs for a long period. Splints are of very little good, and the same applies to more elaborate apparatus; for the straightening of the limb they are apt to produce is by stretching the lateral ligament in the concavity of the curve, rendering the knee-joint weak.

Forcible straightening may be done with the hands in a young child, the bones bending; or if a strain short of breaking be put on a bone, then a week later it will bend, or even break, with the same force, owing to the inflammatory absorption which has gone on in the meantime.

Failing this, the bone has to be broken either by an osteoclast without an external wound, or through a puncture by a chisel, or be cut through by a saw. Thomas's osteoclast may be used to break the bone of children accurately at any desired spot without harmful bruising and without separating instead the neighbouring epiphysis. The advantage of a subcutaneous fracture is a nominal rather than a real advantage, and division by a chisel (or saw) is always necessary in adults. The open operation is both safe and accurate when done antiseptically.

Macewen's Osteotomy for Genu Valgum.—The circulation having been controlled, the limb is flexed and laid on its outer side on a sand-bag covered by a mackintosh. A point is then taken on the *inner* side, two fingers' breadth above the *external* condyle. The thumb-nail compresses the soft parts against the bone, which are then punctured, and whilst holding the point on the bone the skin and soft parts are drawn upwards and downwards against the edge of the knife, and then the chisel is inserted along the knife-blade. The blade of the chisel is first made to cut a transverse groove, and is then hammered so as to cut the bone through on the internal, and next on the anterior aspect; if the patient is near puberty the outer surface is also cut through, as this becomes very hard; finally only the posterior plate of the femur is left. Care has to be taken not to allow the chisel to escape from the groove, lest it should not be returned, and a second notch have to be made; the chisel must not be driven through so as to perforate the soft parts and skin opposite, and the posterior aspect of the bone must not be divided, lest the popliteal artery be injured. The bone is then carefully fractured; in a young child it will bend without parting. The limb is finally fixed in plaster of Paris or on a splint. The latter is best in young children, as the dressing can be immediately changed on being wetted with urine. A double side-splint, the calves resting on a cross-piece, is suitable; a thick pad should be placed on this cross-piece between the outer surface of the leg and the splint. The bandage is then firmly applied, so as to draw the knee outwards, whilst the toes are kept well turned in. The result is a rather excessive inversion of the leg, but this is necessary to overcome a tendency to recoil. If the bandage gets loose, the child may flex the knee, and this may allow of a return of the knock-knee. The knock-knee may relapse if the child is allowed to walk too soon. After ten days the puncture should have healed, or the scar requires merely a pad of ointment. Plaster of Paris can then be applied, and any further rectification carried out before the union has become firm. The plaster is continued for six weeks, when the knees are bent, as the tendons will have stuck in their sheaths, after which the child may be allowed to use his legs.

The fixed apparatus must be continued for three months, or longer where there is tendency to bend, or the child kept in bed, with the legs free.

A curved tibia may be divided by a chisel, the fibula being forcibly fractured, instead of or in addition to the femur.

Bow-leg is operated upon in extreme cases. An old-standing case is difficult on account of acquired rotation outwards at the hip-joint. Generally a division of the tibia below the tuberosities is required.

The complications which have followed osteotomy, viz., suppuration and injury to the femoral or popliteal artery, are easily avoided.

Flail Knee.

This may be paralytic in origin, or follow a too early excision. The joint is generally useless. Amputation may be done, so as to get a firm stump ; or the patient may use a kneeling-pin. Resection may be done, so as to obtain bony ankylosis ; but the limb rarely becomes firm, on account of the atrophic condition of the bones.

Amputation through the Knee.

When there is an abundance of skin for flaps, the broad lower end of the femur affords a useful surface for a stump. There is only one large artery to tie, and there is no muscle in the stump. Two lateral flaps are taken from the upper third of the leg, commencing from the tuberosity of the tibia. The flaps are retracted, the knee flexed, and the knife entered between the upper surface of the tibia and the semilunar cartilages, and these and the ligaments are separated, leaving the former in position on the condyles of the femur. Continuing beyond the joint, the soft parts are cut through horizontally. The popliteal vessels are tied, the nerves drawn out and cut off, the flaps are united so as to drain at the back. After healing, the scar is found drawn up between the condyles behind the femur.

Bursæ anterior to the Knee-Joint.

There are four bursæ : (1) the patellar bursa, (2) the bursa over the tubercle of the tibia, (3) the bursa beneath the ligamentum patellæ, and (4) the subcrureus bursa beneath the quadriceps extensor. The three first have nothing to do with the knee-joint, and are generally affected by excessive kneeling, less often by blows and falls. The subcrureus bursa is connected with the knee-joint, often widely, and is not affected by kneeling, but by injuries and by extension of disease from the knee.

1. **Patellar Bursa.**—It lies over the upper part of the ligamentum patellæ and the lower part of the patella, which separate it from the knee-joint. When it enlarges to the sides of the patella, loose connective tissue and fat separate it at first from the synovial membrane; but later it adheres by fibrous tissue, and a careful dissection is necessary.

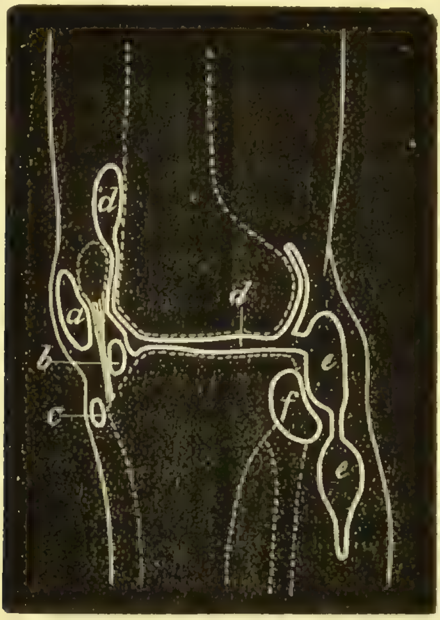

FIG. 106.—BURSÆ AND CYSTS ABOUT THE KNEE-JOINT.

a, Bursa patellæ; *b*, bursa beneath ligamentum patellæ; *c*, bursa over tubercle of tibia; *d*, subcrureus bursa, communicating with general synovial cavity; *e*, *e*, multilocular cystic extension of synovial membrane into popliteal space, and between calf muscles; *f*, semi-membranosus bursa, not communicating with synovial cavity.

Incision of an Inflamed Bursa.—Acute inflammation may be started by an injury, especially if some blood is extravasated into the sac, or it may supervene upon chronic inflammation from kneeling. This may subside upon rest, and the application of cold lotions or an icebag, and aspiration of excess of fluid. If neglected, however—and especially when there is excoriation of the surface—suppuration follows. If not incised at once, the pus bursts into the subcutaneous tissue, and spreads backwards and upwards, but not immediately into the joint. A suppurating bursa is freely incised, and scraped out at once; if the wall is thick, as much of it as possible is cut away. Pockets of pus outside the bursa are cleared out, and either filled with gauze or drained through a counter-opening. The long-continued discharge of pus from a cavity with rigid walls through a small opening will lead to necrosis of the patella, and ultimately the knee-joint may become involved.

Excision of a Bursa.—Whenever much kneeling is done on hard floors, and therefore more often in the case of women than in men, chronic inflammation is set up. In the early stages, protection from pressure with counter-irritation may cure; but when the cavity has become surrounded by a thick wall, or contains a fibrinous mass, there is no other treatment than that of excision. A tumour the size of the fist, or even larger, gradually forms, consisting of hard fibrous tissue, with a cavity in the interior. The skin becomes thinned, and ultimately suppuration occurs. Occasionally sarcoma arises. An enlarged patellar bursa may be excised by a vertical incision, by a transverse one, or by raising up a flap. The edge of the knife is kept well against the tumour; it is better even to leave a bit to be dissected away after removal of the mass.

2. **The Bursa over the Tubercle of the Tibia.**—This is similarly affected, but less frequently, and is treated in the same way.

3. **The Bursa beneath the Ligament,** when enlarged, bulges on either side. It does not go beyond the stage of chronic bursitis, and counter-irritation suffices for its subsidence.

4. **The Subcrureus Bursa** may be considered as part of the knee-joint, and its interior may have to be cleared out in the course of arthrectomy. When affected alone, it may be aspirated or incised on the outer side.

The Popliteal Space.

Cysts and Bursæ.—A cyst arises by a distension of a bursa, or by a bulging of the synovial membrane between the fibres of the posterior ligament. The cause in the former case is obscure; in the latter it is a chronic arthritis, started by a sprain, by injury, or by rheumatism. The commonest cyst is that formed by a distension of the bursa belonging to the tendon of the semi-membranosus in young women, unconnected with the joint. An elastic, non-pulsatile swelling is felt in the popliteal space, which is tense when the knee is extended, and flaccid when bent. A cyst connected with the knee-joint is generally shown by the presence of chronic arthritis, crackling, heat, and fluid in the joint, and the contents of the cyst can be squeezed into the joint. If left alone, the cysts extend into the calf, and make their way between the gastrocnemius and soleus muscles. Ultimately suppuration sets in, causes multilocular abscesses in the leg, extends to the knee-joint, and renders amputation imperative. All such cysts must be excised before complications set in. A bluish wall is exposed on opening the deep fascia, and synovial fluid is let out. The wall is followed up to the pedicle communicating with the knee-joint if one be present, around which a ligature is placed. If there is a wide communication with the joint which contains fluid, the cyst is simply cut off, and the joint washed out. The intramuscular cysts are fully dissected out by extending the incision and retracting the muscles. No portion of the cyst wall must be left, or recurrence will result.

Abscess in the Popliteal Space.—This is due to suppuration in the lymphatic glands; but as the lymphatics come from only a limited area about the heel and back of the calf, a neglected blister on the heel is the usual origin. An abscess may also be secondary to suppurative disease of the femur or knee-joint. In obscure cases an abscess must be distinguished from an inflamed popliteal aneurysm by controlling the circulation by a band, and exploring with caution, avoiding injury to the vein, etc.

An Exostosis grows from the back of the epiphyseal line of the femur, and the patient usually presents some signs of past rickets. As it is attached to the diaphysis, the exostosis moves up the femur with growth. It is easily recognised as a hard mass attached to the femur. The complications of an exostosis are suppuration, fracture, and separation, pressure on the popliteal artery so as to obliterate it or to cause an aneurysm, or it may become the seat of malignant disease. The knee is laid on its outer side, flexed to draw down the synovial membrane; an incision is made over it, the soft parts separated bluntly to avoid the anastomotic or popliteal vessels. The exostosis is then sawn off, or cut off by a chisel.

Popliteal Aneurysm.

This is the commonest of the aneurysms treated by surgeons. It nearly always occurs in men, especially during the active period of life, and is very commonly bilateral, except when traumatic.

Spontaneous popliteal aneurysm commences in connection with the bifurcation of the popliteal artery. Syphilis and alcoholism are looked upon as predisposing causes, and arterial disease, with thrombosis, as an exciting cause. It is at first circumscribed, and is especially well felt on flexing the knee, whereas a cyst tends to disappear. There is no difficulty in the diagnosis of an early case. If not treated, it enlarges so as to fill the popliteal space, and then gradually invades the calf, or encroaches on the femur and the knee-joint; or it may become rapidly diffused downwards into the calf between the muscles.

Traumatic aneurysm arises from a sprain, and especially from fracture of the lower third of the femur. An aneurysm may be also caused by an exostosis growing from the back of the femur.

Rest is of no permanent service.

Digital compression requires a relay of skilled assistants, for the pressure must certainly be kept up for twelve hours or more at a time. It can be made by grasping the limb with the hands, and pressing with one thumb over the other upon the artery in front of the femur in Scarpa's triangle. Or the fingers may be used, supplemented by the pressure upon the fingers of the other fist, or a bag of shot. Or the assistant may stand beside the patient lying on a low bed, and press on the artery with his closed fist whilst keeping his arm straight. In any case, after five to ten minutes, the arm and hand become numb. When changing, the fresh-comer must compress the vessel above or below before the other relaxes. Compression may also be made with tourniquets, but they are not suitable for restless patients. The least movement lets the vessel slip from beneath the pad.

Ligature is generally the quickest and most satisfactory treatment. This may be done by the direct operation, or by ligature of the superficial femoral artery at the apex of Scarpa's triangle. The latter is easy, and free from danger before the aneurysm is diffused. But it may fail to cure, and then the direct operation is required. The circulation being controlled, a median incision is made down to the sac, the blood-clot turned out, the artery ligatured above and below, and the sac excised. Special care has to be taken not to injure the vein or the nerves. The direct operation is especially suitable for traumatic cases, and for diffused aneurysm when the blood-clot, by its pressure, hinders the anastomotic circulation. It was formerly opposed on account of the danger of secondary hæmorrhage from the giving way of the proximal ligature, but under antiseptic measures this mishap is not likely to occur. When the aneurysm has become diffused, there is danger from gangrene, following either the ligature of the femoral or of the popliteal. The leg and foot should be kept wrapped in thick cotton-wool from the first, so as to favour anastomosis before the operation as well as after; likewise the limb is elevated a little above the trunk to aid the venous return, and no tight bandaging is employed after the operation. If gangrene ensues, the part is kept as dry as possible, and the formation of a line of demarcation is awaited. If the gangrene is limited to the toes or foot, the amputation immediately above the line of demarcation is postponed until the circulation in the leg is fully restored. If, however, the gangrene spreads up the leg, amputation through the knee-joint or just above the condyles should be forthwith undertaken.

Arterio-Venous Popliteal Aneurysms are due to punctured and bullet wounds. Both artery and vein may be doubly ligatured without gangrene following.

CHAPTER XLII.

SURGERY OF THE LEG AND FOOT.

Fracture of Both Bones of the Leg.

It is commonest below the middle, and is rare above, except from direct violence. Falls from a height are the common indirect cause. A fracture from muscular violence alone is doubtful, except combined with some pathological fragility of bone.

Direct violence is of all kinds and degrees, a fall with the leg doubled in under being a mild type. About a third are compound. The fracture is transverse or oblique, the fibula being fractured about the same level or at some distance away—*e.g.*, the tibia in the lower third, and the fibula in the upper third.

The important displacement is of the lower fragment backwards, due to its unsupported weight, and to the pull of the calf muscles through the tendo Achillis upon the os calcis. The lower end of the upper fragment is prominent beneath the skin from the displacement back of the lower fragment.

An open or compound fracture may have a small lacerated wound, which communicates either directly or only indirectly with the fractured ends; or the end of the upper fragment protrudes through the skin, or there is extensive laceration, wide extravasations of blood beneath the skin and amongst the muscles, and free exposure of the fractured ends. The diagnosis presents no difficulty in fracture of both bones, although it is possible for a patient when the fractures are transverse and subperiosteal to make some attempt at walking. Crepitus is plainly obtained if no muscle or fascia has got between the ends of the bones.

A fracture of the leg is a very common accident, and, if properly treated, perfect recovery follows. But there is little doubt that the treatment is not so good as it should be in all cases, thus entailing a weak and painful leg, and a great loss of earning power. There are four important points: (1) The complete and immediate reduction of the fracture, especially the restoration from displacement backwards of the lower fragment; (2) the thorough antiseptic treatment of an open or compound fracture; (3) the maintenance of the bones in good position until there is firm union; (4) the restoration of the movements of the muscles and tendons of the leg.

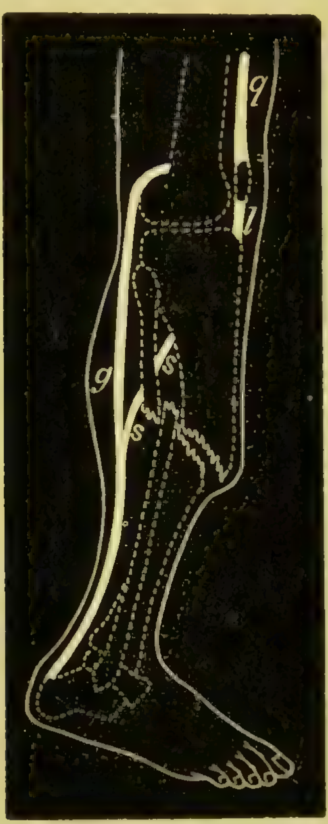

FIG. 107.—FRACTURE OF BOTH BONES OF LEG.

q l, Quadriceps extensor muscle and ligamentum patellæ, acting on upper fragment, keeping it extended at the knee-joint; *g s*, gastrocnemius and soleus muscles, drawing the unsupported lower fragment backwards and upwards whilst extending the foot at the ankle.

(1) *The Complete and Immediate Reduction of the Fracture.*—Whilst lateral deviations are perceived by glancing along the line of the leg, the backward displacement can be fully seen

only when the eye is on a level with the leg, held horizontally by an assistant, one of whose hands grasps the toes, the other being placed behind the knee. Reduction is made by extension on the lower fragment, the hand grasping the heel and bringing it well forward. When this is complete the leg should be as the other; the finger on travelling down the spine of the tibia should meet with no angle at the site of the fracture. The foot should be capable of being dorsiflexed as much as the other. Reduction may be easily accomplished; if not, the patient must be anæsthetized. Supposing, then, that the reduction is not perfectly satisfactory, the difficulty lies in the tenseness of the tendo Achillis, or from muscle or fascia between the ends of the bone. If the tendo Achillis is not sufficiently relaxed by the anæsthesia, tenotomy should be unhesitatingly done, and the foot dorsiflexed as much as the other; this will bring the heel well forwards, and tip back into position the upper end of the distal fragment. Muscle or fascia between the ends of the bones is indicated by the want of clear crepitus. Gentle movements of the two ends on one another are made, and any impaction is released. In the exceptional case of failure to obtain perfect reduction by the above measures, a subcutaneous fracture may be cut down upon and fixed in a good position.

(2) *The Antiseptic Treatment of an Open or Compound Fracture*, see p. 119.

(3) *The Maintenance of Position after Reduction.*—A back-splint with a footpiece and side-splints, slung in a cradle, is the general apparatus. The splint is well padded, covered with gutta-percha tissue if for a compound fracture; the footpiece is at a right angle; the side-splints are broad, so as to prevent the webbing or bandages from touching the leg at all. A thick pad is placed under the tendo Achillis (not under the heel, which should always be raised a finger's breadth from the splint), and other pads may be placed within the side-splints to overcome lateral deviation. The side-splints are held in position by webbing and buckles, and the foot bandaged to the footpiece. No bandage is needed to retain the dressing in position, or, at most, the dressing must only

be loosely applied, so as to avoid venous congestion. The leg is slung with the knee a little flexed, which relaxes the calf muscles and avoids pulling on the heel. When all swelling has subsided or the wound healed, a plaster of Paris bandage may be applied so as to include the leg and foot, the latter being flexed to fully a right angle; but this is only needed where there is still mobility of the fragments.

(4) *Restoration of Movement of Muscles and Tendon.*—In all bad cases there is danger of a serious limitation of movement, so that after union the ankle-joint remains stiff, the leg weak and swollen from venous congestion; it is impossible to stand on tiptoe, and the patient has to walk on his heel. In all such cases, therefore, as soon as the fracture begins to be firm, massage is commenced, viz., stroking in the direction of muscles, rotatory movements with the palm over indurated spots, side-to-side movements of muscles and tendons by kneading with the thumbs, and passive movements at the ankle-joint. If union is delayed, the patient may wear a poroplastic, silicate, leather or plaster of Paris case cut down in front, which can be taken off to allow of the massage.

Fracture of the Tibia only.

Fracture in the Upper Third of the tibia is rare as compared to fracture below; it is generally due to direct violence, and is therefore often compound and comminuted. A crush may cause extension to the knee-joint. There is no displacement by muscle. A separation of the epiphysis may take place before twenty years of age.

The treatment will be directed to avoiding suppuration and necrosis in the case of a compound fracture. If the knee-joint is involved, the leg must be at first kept straight, and passive movement be begun as soon as the pain is less.

The Spine of the Tibia.—The tibial spine has been torn off by muscular violence, and, for the same reason as in the case of fracture of the patella, must be fixed. This can be done by holding it in position and driving in an ivory peg, the projecting end of which is cut short, and the skin pulled up over it. Or the tubercle can be sutured in position through an incision.

Fracture through the Middle and Lower Third.—When the tibia is fractured alone the cause is generally direct violence. There is either no displacement or a little rotation backwards of the lower fragment. It is sometimes overlooked; the patient walks about; a false joint forms, and the fibula undergoes hypertrophy.

A plaster of Paris bandage, with a pad of wool over the site of the fracture, including the foot, is generally sufficient. If there is much swelling or a compound fracture, treatment on a splint is necessary for a short time.

Injuries of the Fibula only.

The Upper End of the Fibula may be torn off at the epiphyseal line before or after union, by the forcible contraction of the biceps when the knee is partly flexed. The external popliteal nerve is liable to injury either from the foregoing muscular or from direct violence. It is noted by pain in its distribution, also by partial or complete paralysis of the peronei and extensors.

Dislocation of the Upper End of the Fibula.—The dislocation may be forwards by direct violence, backwards by muscular violence when the leg is flexed, or a dislocation may complicate a fracture of the tibia. It is easily reduced. The end of the bone, if displaced repeatedly, is fixed by pegging or sutures. The external popliteal nerve may have to be freed from scar tissue or reunited.

Fractures of the Shaft of the Fibula.—These occur from falls on the feet with twists, or from direct blows and squeezes. It very commonly accompanies a dislocation at the ankle-joint. It is often overlooked. The fibula is examined by pressing it towards the tibia. When there is a fracture, the loss of the normal spring is noted, and pain is felt at the site of fracture when pressure is made on some distant part of the bone; *e.g.*, pain may be felt in the lower fourth of the bone when the upper third is compressed against the tibia. Crepitus may or may not be recognised; the loss of spring and the persistent pain at a spot are sufficient indications for treatment. An ununited fracture may cause some thickening of the bone at the spot, and hypertrophy of the tibia. A plaster of Paris bandage, including the leg and foot, is put on for a short time, and then passive movement and massage are employed.

Sprains of the Leg.

When a rupture of some of the muscular fibres in the calf of the leg takes place, there is a feeling as of a sharp stroke from a whip. This is followed by local stiffness and induration, relieved by rest and massage. If extensive, a hæmatoma forms, which .may end in a cyst or suppurate, but generally is spontaneously absorbed.

The Tendo Achillis.

After a slight strain in a gouty patient, troublesome persistent pain may be experienced. The tendon may be completely ruptured, either from violent contraction in springing or from falls on the toes. It is generally seen only in those past middle life. There is no fear of non-union, for the torn ends cannot retract from each other, owing to being united with the sheath. Whilst healing is progressing the foot is kept extended.

Injuries to the Arteries of the Leg and Foot.

These do not give trouble, for they can be easily controlled by pressure against the adjacent bone. When a ligature is required, the patient is anæsthetized, the circulation controlled by a rubber band round the limb above, and the wound enlarged, if necessary, in the line of the vessel, to which, when exposed, a double ligature is applied.

Traumatic aneurysm occasionally originates from a punctured wound, *e.g.*, in the calf or on the inner side of the ankle, or in the course of the dorsalis pedis or of a plantar artery. The aneurysm can be generally cured by direct compression, or it can be excised by proceeding as for a punctured wound.

Injuries about the Ankle-Joint.

There are two common injuries—a sprain and a Pott's fracture.

Sprain (Recent).—This is attended by strain of tendons and rupture of the vascular synovial membrane, and consequently extravasation of blood, and the stretching or rupture of important ligaments, the internal or external lateral ligament, the calcaneo-scaphoid or plantar ligaments. Immediately after an accident a fracture or dislocation may be easily perceived. When much swelling has occurred, there may be a difficulty, but the signs of Pott's fracture are so characteristic that it can generally be recognised. A sprain may leave a weak and lax lateral ligament, so that the ankle tends to give way on one side, or, by the stretching of the calcaneo-scaphoid ligament, flat-foot is likely to be produced. By adhesions taking place in the tendon-sheaths around the joint, the ankle may remain extended, and the foot stiff and painful.

If the sprain appears to have been severe, and is seen before the swelling has commenced, the foot and ankle are wrapped in wool, over which a firm bandage is placed. The firm bandage prevents effusion, and is left on for a week, and then free movements are begun.

If the swelling has already occurred, cold lotions are applied, and, as soon as possible, massage and free movement. The massage hurries on the absorption of the extravasated blood, and the movement prevents adhesions.

Sprain (Old-standing).—Pain may be felt owing to adhesions; these are broken down under nitrous oxide gas, and free movements kept up afterwards. The pain may be due to relaxed ligaments, which may be strengthened by exercising the corresponding muscles—the peronei in order to support the external lateral ligament, the extensors and flexors to support the internal lateral, the calcaneo-scaphoid and plantar ligaments. The foot may be held under a cold-water tap, liniment or mercury ointment rubbed in, iodine or a blistering fluid applied. If the pain resist treatment, scoring the skin ('firing') with the actual cautery relieves the pain and promotes shortening of the ligaments.

Fractures and Dislocations about the Ankle-Joint.

The common Pott's fracture is a partial dislocation outwards and backwards, with a fracture of the fibula. The ankle-joint is purely a hinge joint without lateral movement; the lateral movements of the foot take place in the tarsal and metatarsal joints.

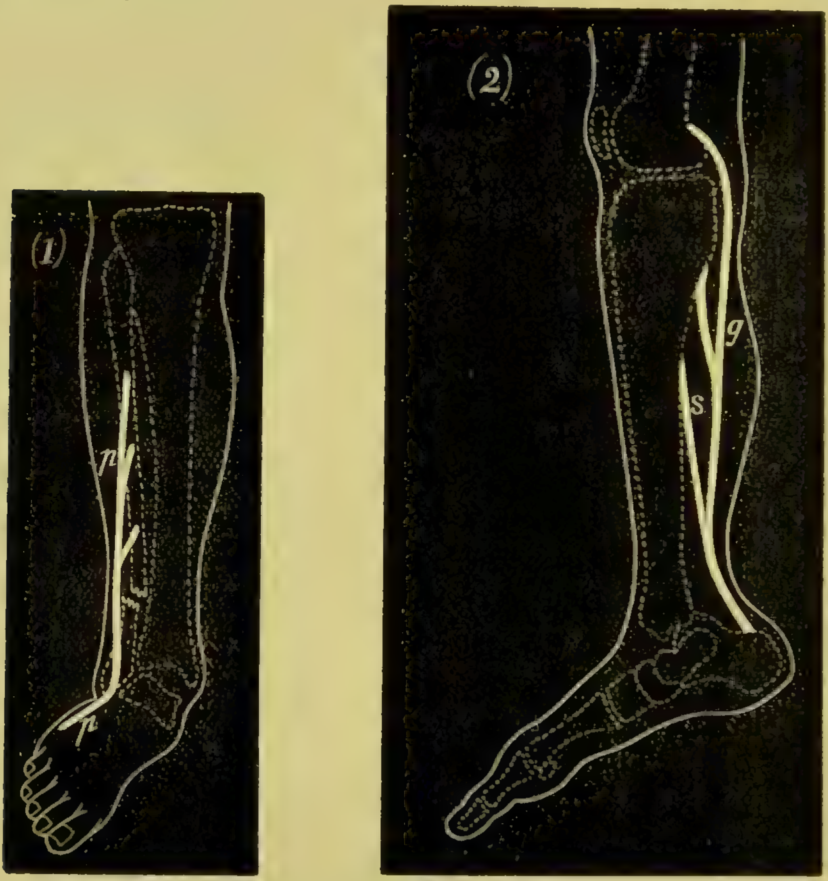

Fig. 108.—Pott's Fracture-Dislocation at the Ankle.

(1) Fracture of fibula—dislocation of foot outwards: *p p*, peronei muscles causing eversion. (2) Dislocation backwards: *g s*, gastrocnemius and soleus muscles causing extension.

Abduction at the ankle is especially prevented by the external malleolus. When the foot is forcibly abducted, the internal lateral ligament or the internal malleolus gives way; this allows the astragalus to press against the external malleolus, which, being held to the tibia, usually fractures in the lower fourth, or less often in the upper third; more rarely there is no fracture of the fibula, but a separation from the tibia by a giving way of the ligament uniting the two immediately above the joint surface. In either case, whether the fibula be fractured or merely separated from the tibia, the foot is abducted, rotated outwards on an antero-posterior axis, so that the inner part of the upper surface of the astragalus separates from the tibia. Partly owing to the force of the accident, partly owing to the contraction of the calf muscles, the foot is moved backwards and extended on the leg.

The signs of a Pott's fracture are the abducted and extended foot, the greater prominence of the heel, with corresponding shortening of the foot in front. There is a gap on the inner side; the inner malleolus or its fractured base is close beneath the skin, which may be punctured or lacerated at this point.

If allowed to remain unreduced, the patient has an everted and also an extended foot. He can only bear a little weight on the inner side, and cannot raise himself on tiptoe.

In order to reduce the fracture, one hand grasps the heel, and the other rests on the front of the leg, whilst the heel is forcibly drawn forwards and adducted. The reduction is only complete when the foot can be well adducted and dorsiflexed beyond a right angle. If reduction is not quite complete, an anæsthetic must always be employed. The tendo Achillis is divided when necessary. Tenotomy then shows that the chief obstacle to reduction of a Pott's fracture is the calf muscles, and this becomes the more marked the longer the time which has elapsed since the accident.

The rest of the treatment is similar to that for fracture of the leg. A back-splint with foot-piece and side-splints is the best. A side-splint, with the leg laid on the outer side, overcomes the eversion, but is not so satisfactory for the displacement backwards and extension of the foot.

An old unreduced Pott's fracture is treated by tenotomy, by wrenching, or by osteotomy of the fibula, if the bone has been united at an angle.

Other Fractures and Dislocations of the Foot at the Ankle.

Dislocation Inwards.—This is rare as compared with Pott's fracture, and is due to forced adduction of the foot. The external lateral ligament yields, or the external malleolus is fractured. The astragalus pressing on the inner malleolus may fracture it.

The foot is well abducted and brought forwards, then treated as in the case of a Pott's fracture.

Dislocation Backwards.—This may be looked upon as a modification of a Pott's fracture.

Dislocation Upwards.—This is another modification in which the astragalus is wedged in between the widely separated tibia and fibula, the interosseous ligaments giving way instead of the fibula.

Dislocation Forwards has happened from the foot being forcibly dorsiflexed on the leg. A man placed his toe on the curb, his heel sunk into the gutter, and he fell forwards on to the pavement. The foot was found dislocated forwards.

Separation of the Tibial Epiphysis may happen before puberty.

Fractures and Dislocations of the Tarsus.

The Astragalus is displaced by violent wrenches whilst the foot is extended, *e.g.*, in falling on the toes. One may assume a relative weakness of the calcaneo-astragaloid ligament, which yields, and the astragalus is displaced on the os calcis, instead of a Pott's fracture being caused.

The head of the astragalus may be partially or completely separated from its articulation with the scaphoid, and form a prominence on the inner side of the dorsum. It is easily pressed back into position.

The astragalus may be completely dislocated from its articulation with the scaphoid, os calcis, and bones of the leg, and be found lying beneath the skin. It may be possible to replace the bone by manipulations under anæsthesia; but if it is also twisted, this will be impossible, and the bone should be excised. A useful joint is formed between the tibia and fibula and the os calcis. If the astragalus is not quickly excised, the skin may become gangrenous over it; indeed, the astragalus is said to have been driven out through the skin by the force of the accident.

Subastragaloid Dislocation is a separation between the astragalus still in position in the ankle-joint and the rest of the foot. The causes are similar to those producing Pott's fracture and dislocation of the astragalus, the displacement of the os calcis and the rest of the foot being nearly always outwards and backwards. The separation is generally complete between the astragalus and scaphoid, and incomplete between the astragalus and os calcis. The under surface of the astragalus projects on the inner side.

Reduction is made by pulling the heel forwards, and adducting under an anæsthetic, the tendo Achillis being divided if there is any difficulty.

Fracture of the Astragalus.—The astragalus has been fractured with or without dislocation.

Fracture of the Os Calcis is usually due to falls on the heel from heights, and is therefore often bilateral. It has occasionally been due to lateral pressure, and in some cases the projecting end has been torn off by muscular action, and the fragment drawn up.

Rest until weight can be put on the heel is required. If the fragment is drawn up by the tendo Achillis, it should be fixed down in position by a peg driven horizontally through the fragment into the os calcis from the point of the heel.

Injuries to the Fore-Part of the Foot.

The rest of the foot is subject to sprains tending to stretch the ligaments between the scaphoid and the os calcis behind and internal cuneiform in front. and to cause flat foot. The foot is so protected by boots that only severe crushes, bullet wounds, etc., cause open wounds.

Rest and cold applications are required, with careful antiseptic treatment of compound comminuted fractures in order to avoid necrosis.

Amputation through the Foot.

This may be done in any way that flaps can be suitably obtained; the bones and joints of the foot being treated as one solid mass. In the case of a crushed foot, as much is saved as possible, and this applies especially to the inner part and to the great toe.

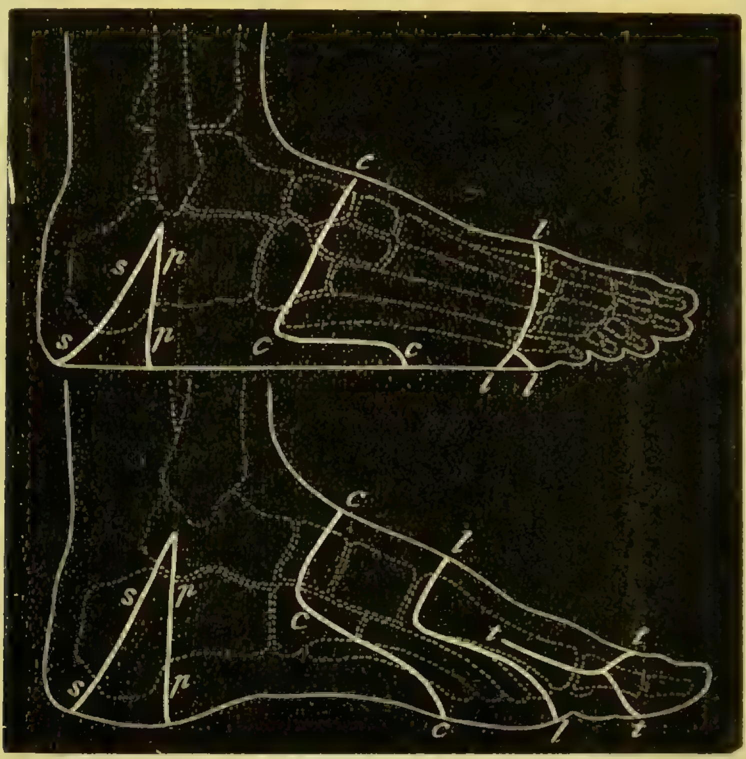

Fig. 109.—Amputations through the Foot.

Lines of incision: *s*, Syme's; *p*, Pirogoff's; *c*, Chopart's; *l*, Lisfranc and Hey's; *t*, amputation of great toe.

Amputation of the Toes.—A racket-shaped incision is used, the longitudinal incision being on the side for the great and little toes, and on the dorsum for the others. The circular incision should go round the first interphalangeal joint, in order to cover the head of the metatarsal bone. Supposing there is not sufficient skin, the head has to be cut off; but this loss is a very important one in the case of the great toe, as it removes one end of the arch of the instep.

Lisfranc and Hey's Amputation is through the junction of the tarsus and metatarsus, making a long posterior flap, but no anterior one, for the reason given below.

Chopart's Amputation.—This is at the mid-tarsal joint. There must be no anterior flap. The posterior flap must reach as far as the toes, especially on the inner side, and include all the soft parts of the sole. If an anterior flap be made, the scar is drawn down towards the sole, and the stump becomes a painful one from pressure on the scar.

Pirogoff's Amputation is through the ankle-joint. An incision is made from a point just below and behind the internal malleolus, and continued under the os calcis to the tip of the external malleolus in a line which is vertical, in the upright position. It is carried down to the bone: and then the os calcis is sawn through so as to cut off the hinder end. A transverse incision is made in front through all the structures, and the cartilaginous ends of the tibia and fibula cut off. Then the hinder end of the os calcis is applied to the cut surface of the tibia, and fixed there by a peg. The patient walks on skin belonging to the back of the heel, and he does not suffer any loss in height. It is an operation unsuitable for tubercular disease involving the os calcis.

Syme's Amputation removes the foot at the ankle-joint, the stump being covered by thick skin from the back of the heel. It is commenced by outlining the posterior flap, from a point just below and behind the internal malleolus round the point of the heel to the tip of the external malleolus, the knife being carried at once down to the bone. Then the foot is fully extended, and the anterior incision is made transversely between the two ends of the posterior incision. All the structures in front of the ankle are divided, also the lateral ligaments. The posterior flap is then raised by keeping the edge of the knife against the os calcis throughout. The ends of the tibia and fibula are sawn off, or only the tips of the malleoli clipped away. The dorsalis pedis and the plantar arteries require to be ligatured. The incision must be strictly adhered to, for, whilst the flap must be sufficiently large to cover the bone, it must not be large enough to allow exudation to collect in it. Moreover, great care must be taken not to buttonhole the flap, for when the amputation is done in patients above forty, sloughing may easily be caused by impairment of the blood-supply to a thin or perforated flap. If the flap does slough, re-amputation through the leg must be done, but this may be too much for an old and exhausted patient.

When the heel has been honeycombed with sinuses, Syme's amputation may be modified, and a lateral or antero-lateral flap made instead.

Amputation of the Leg

may be done at any point by antero-posterior or by lateral flaps. By whichever method, the flap from the anterior half of the leg is raised from the bone, so as to take up the anterior tibial artery. This is done by keeping the edge of the knife against the tibia, fibula, and interosseous membrane. The posterior half includes skin and subcutaneous tissue, but no muscle. The flaps require to be in length about one and a half times the diameter of the limb at the point of section ; they should not be longer, or ulceration may ensue, especially if the arteries are at all calcareous. Indeed, if this latter condition is obviously present, the operation should be changed at once to amputation through the lower third of the thigh. The sharp ridge of the tibia is shaved off obliquely. The anterior and posterior tibial and the peroneal arteries require ligatures. The patient is fitted with a bucket stump, or, if in the upper third, may walk kneeling on a pin-leg.

Amputation for Injuries to the Leg and Foot.

Primary Amputations.—In cases of extensive crushes or gunshot injuries, the limb may be practically cut off by the accident, and there is nothing left for the surgeon to do but to trim the stump. The only question then which arises is as to whether the limb has been damaged higher up, and whether the operation should be delayed until there is some recovery from shock. If no hæmorrhage is going on, it will be best to wait for an hour or two, administer a hot enema with brandy, and wrap up the patient until he becomes warm.

In cases of doubt there are three points for consideration: (1) Damage to all the bloodvessels of the limb, the popliteal, or the three tibial, or both plantar arteries and veins; (2) wide exposure of bones and joints; (3) extensive destruction of skin.

Wide exposure of a bone or joint is not now an indication for primary amputation. Complete antiseptic measures are used which may be successful, or a secondary amputation may be required, supposing that later on the patient shows evidence of exhaustion. Extensive destruction of skin, owing to crushing, burning, etc., may be replaced by skin-grafting, and the movements of tendons, and the return of lymph afterwards, accelerated by massage and movement.

Complete division of all the main vessels points to immediate amputation, but thorough exploration should be made, to see whether the vessels are merely compressed by the fractured ends or by blood-clot, or whether the wound of the artery or vein is only small, and may possibly be repaired by suture.

In cases of doubt, the fracture is replaced, blood-clots removed, and then a small incision may be made into the foot, to see if there is any blood circulating through the small vessels, or the amputation may be put off for some hours, to make certain whether the limb below the fracture is dead.

Secondary Amputation is required at once, should septic inflammation or spreading gangrene have supervened, and should generally be through the thigh.

It may also be required for prolonged suppuration, or the stump of a primary amputation may have to be resected.

Amputation of the Leg for Malignant Disease.

Malignant Ulcer.—The rapid fungation or overgrowth of the granulations covering a chronic ulcer may indicate the development of some form of sarcoma. The diagnosis may be confirmed by microscopical examination of a piece. The ulcer, if small, may be freely excised and the wound dressed with gauze, and later on covered with skin-grafts; but when extensive, the limb must be amputated well above the disease.

Epithelioma is a rare complication. It is an open question whether it follows directly upon a chronic eczema, or whether there is an intermediary stage in which the ulcer is benign. The ulcer is recognised by its indurated and everted edges, and by the nest cells found in scrapings, or, better still, in pieces removed from the ulcer. An ulcer may fungate, or, on the other hand, rapidly break down, forming a deep cavity, which soon reaches the bone. In aged people an epithelioma may grow very slowly, and is, in fact, a rodent ulcer. Sooner or later the femoral glands enlarge. Amputation through the thigh and removal of the enlarged glands in the groin are generally indicated for late cases, but if the growth is slow and the disease limited, local excision and subsequent skin-grafting may be tried.

Myeloid Sarcoma (Giant-Celled Myeloma) of Bone.—It most frequently occurs in the head of the tibia, less often in the lower end or in the fibula, more rarely still in one of the bones of the foot, *e.g.*, the os calcis. It is apt to undergo myxomatous degeneration, the bloodvessels give way, and a blood-cyst is caused, which pulsates owing to its connection with an artery, but some of the sarcomatous tissue will be found in the wall.

It is an open question whether there is such a thing as a true aneurysm of bone, or whether a pulsating tumour is not always due to the above degeneration.

A slow-growing, hard tumour, originating within one of the bones of the leg, especially the head of the tibia, after a gumma has been excluded, is cut down upon. If the myeloid tumour, consisting of brown material, more or less mixed with blood-clot, is still enclosed in its shell, it is removed, the shell well scraped out and filled with gauze. If the tumour is larger, a portion of the tibia or the fibula also may be excised. If the muscles are already invaded, amputation is done just above the growth, and great confidence may be felt that the patient will be cured.

Periosteal Sarcoma.—It generally grows about the middle of the shaft, but may do so from any point in the leg or foot. A slight blow appears to often start the disease. The growth is rapid, at least four times that of a myeloid. On incision, brainlike tissue, or cartilage mixed with fibrous tissue, is found, not pigmented, and growing from the surface of the bone. Amputation through the lower third of the thigh, and excision of the glands in the groin if enlarged, is the only thing that can be done. But the development of metastatic growths in some internal organ nearly always takes place within six months.

Amputation of the Leg and Foot for Gangrene.

Traumatic Gangrene.—This is directly the result of mechanical violence, occluding the bloodvessels, or the result of cold—frost-bite. The limb is kept warm, the affected part covered with iodoform and dry wool; any bullæ which appear are snipped open, and the contents let out. The formation of a line of demarcation between the dead and living is looked for. The dead part assumes a pale, then dull-blue, appearance, which gradually becomes blacker. Sensation is lost, and no bleeding follows on puncture. The living shows a zone of redness, and at the junction of the dead and living a chain of pustules forms, and upon the removal of the epidermis covering these pustules a gutter-like ulcer is exposed winding irregularly round the limb. As soon as this line of demarcation is perceived, amputation should be done above through the healthy part.

Traumatic Inflammatory Gangrene—Spreading Traumatic Gangrene.—When septic infection takes place at the time of the injury, the limb becomes rapidly swollen and œdematous, and this is followed by gangrene. Within a day of the injury, the gangrene may have spread up the leg, and during the second day reach the thigh. The disease is fortunately rare, and is prevented by antiseptic treatment of the wound. When it has once set in, amputation through the thigh must be done above the zone of œdema. If the amputation traverses the œdematous zone, the flaps are kept apart by iodoform gauze to prevent the products of septic inflammation from collecting in the stump.

Gangrene from Arterial Obstruction.—This is due to the narrowing by atheroma and calcareous disease of the blood-vessels, or to their actual occlusion by thrombosis. Diabetes, alcoholism, albuminuria, gout, syphilis, or simply old age, all act as causes of the arterial disease. Gangrene also arises from embolism following heart disease, and from thrombosis in septic infections, such as puerperal and typhoid fever. Spasmodic arteritis causes a very slow and limited dry gangrene, especially of the fingers in young women (Raynaud's disease), whilst chronic poisoning by ergot affected especially the toes and feet of men. In Raynaud's disease, as well as in gangrene from chronic ergotism, as little as possible is done locally beyond assisting the separation of the dead part. At the other extreme is the sudden and extensive moist gangrene from heart disease, puerperal and typhoid fever, embolism, or thrombosis. The gangrene begins by involving more or less of the whole leg and foot at once, and often on both sides. Amputation through the thigh may be tried, but success is not likely.

Senile and Diabetic Gangrene.—The predominant factor is the calcareous degeneration of the tibial arteries, whilst the popliteal artery is comparatively healthy. In addition to the reduction of the lumen by the thickening of the walls, the vessels become gradually more and more blocked by thrombi.

Premonitory symptoms are aching and burning pains in the foot and leg, cramp in the calf, pallor and numbness, or pitting, of the toes, dusky patches leading to desquamation. Attention may in this way be drawn to the fact that the superficial vessels—temporal, radial, dorsalis pedis—are hard and tortuous, and that the patient has traces of albumin or of sugar, or of both, in the urine. Such patients should wear thick woollen stockings both by night and day, loose shoes, and should avoid cold and damp feet, as well as a hot fire or direct contact with a hot-water bottle. There is a special danger from small scratches or cuts made in removing corns or nails. Such a case is treated by giving a little alcohol, coffee, and an opium pill at night, the latter not only relieving pain, but also improving the circulation in the extremities, as does also the coffee. If there is any considerable amount of sugar in the urine, the special diet, as well as a regular course of codeia or opium, is needed.

The gangrene generally begins insidiously; a dusky, œdematous patch of skin gradually gets blacker. Other toes may follow suit. Less often, especially following a small cut, gangrene begins and spreads rapidly. As long as the patches are superficial and confined to the toes, the leg and foot are kept wrapped up, and the gangrenous patch dry and covered with iodoform. Meanwhile, general treatment is followed. The black patch may separate, and healing follow. When, however, the gangrene has spread beyond the toes, some active surgical measures are required, unless the patient is to continue in bed, and succumb from bed-sores, congestion of the lungs, etc.

Whenever there is marked arterial sclerosis—*e.g.*, when the dorsalis pedis is felt as a hard cord, when the pulsation of the posterior tibial behind the ankle cannot be felt—then the only permissible amputation is through the lower third of the thigh. The main artery and the small vessels are at this level healthy. The severity of the operation is not markedly greater than a lower amputation, especially as the stump heals at once, and the shorter stump is a nominal rather than a real disadvantage to an old patient.

Amputation of a big toe, through the foot, at the ankle, or through the leg, has so often ended in utter failure, consequent upon gangrene of the flaps and the death of the exhausted patient, that it should never be tried unless it is clear that the dorsalis pedis and posterior tibial arteries are beating freely. If, during such an amputation through the leg or foot, evidences of narrowed or thrombosed vessels are found, the operation ought to be changed at once to amputation through the thigh.

Diabetes and albuminuria, when occurring separately or together, but not in large amount, do not contra-indicate the high amputation, rather the reverse, and improvement often follows, the sugar and albumin falling to a mere trace or disappearing altogether. The stump heals well in such cases.

Amputation for Chronic Lymphatic Obstruction—Elephantiasis.

The foot, leg, and thigh become affected with œdema, fluid fills the lymph spaces so tensely that no pitting occurs on pressure (solid œdema), the limb becomes three or four times its proper size, the skin rugose, vesicles containing lymph burst, and the continuous exudation keeps up an eczema. The enlargement is due to the great thickening of the deeper layers of the skin and subcutaneous tissue by the inflammatory fibrous tissue surrounding the lymph spaces.

The lymphatic obstruction is said to arise in the tropics from parasitic worms—*e.g.*, *Filariæ*. But the disease occurs sporadically in this country in people who have never been out of the country, nor had to do with those who have been in the tropics. A similar obstruction of the lymphatics may occur as the result of long-continued ulceration of the leg.

If the patient stays in bed, and the limb is carefully and regularly compressed by an elastic bandage applied from the foot upwards, a great reduction in size occurs in all early cases. The effect is increased by hot fomentations and massage. But no real advantage may be obtained, and the patient is disappointed when, upon getting up, his leg returns to the same size as before.

Amputation through the thigh is required in order to get rid of a great encumbrance. If the elephantiasis has reached the level of the amputation, there is much exudation from the divided lymph spaces.

Incision for Acute Inflammation of the Tibia and Fibula.

Acute inflammation, termed, according to its origin, acute epiphysitis, acute periostitis, or acute osteo-myelitis, is due to pyogenic organisms, especially the *Staphylococcus pyogenes aureus*. It occurs most frequently in boys, and is often preceded, when primary in the leg, by a small injury. The inflammation occurs most frequently in an epiphyseal end of the diaphysis of the tibia, from which extension may take place to the knee or ankle-joint, or to the shaft. Less often it commences under the periosteum in the middle of the shaft, or in the medullary cavity. Its occurrence is indicated by the signs of fever, by pain, redness, and induration, or even œdema and fluctuation. An immediate incision must be made the whole length of the abscess, and all the pus removed. Subacute and chronic inflammation is similar in origin, but is often secondary to some infective process, such as syphilis, scarlet fever, typhoid fever. The presence of pus may be indicated by similar but less severe symptoms. One or more sinuses may have already formed after the bursting of an abscess. The signs of an abscess within the bone may be limited to pain and aching of a variable character, but increased by firm pressure over the spot; also there may be slight elevations of the temperature and pulse. Upon incising over the spot, the periosteum is found thickened, the bone beneath soft and vascular; a cavity may be opened containing oily fluid or pus, with or without a sequestrum. If no cavity is found, the surgeon confines himself to gouging or trephining a hole into the centre of the bone, and in addition boring may be made in various directions with an awl. And frequently relief is afforded, although no cavity nor pus be reached, by the lessening of periosteal and osteal congestion.

When a cavity is reached, it must be freely laid open by a longitudinal slit in the bone; the cavity is scraped out, all dead bone chiselled away, and the hollow filled with antiseptic gauze. This gauze is changed daily until the cavity has filled by granulation tissue, complete healing being hastened by skin-grafting. If an incision is made early, no necrosis need take place. If necrosed bone is freely removed before the periosteum is destroyed, new bone is formed in place of the old, and this new formation may be favoured by bone-grafting. In addition the other bone will hypertrophy, and take more part in supporting the limb.

Excision of Varicose Veins.

Varicose veins of the leg are most often due to a congenital weakness of the vein walls, especially when they appear about puberty, and other members of the patient's family may be found similarly afflicted. Varicose veins are greatly aggravated by pregnancy; indeed, they appear quite early. In other cases, long standing without muscular exercise causes the veins to become varicose, as also does work before a fire or in a hot climate.

Apart from congenital weakness, the veins of the leg become dilated owing to obstruction in the large venous trunks. Phlebitis, set up by typhoid fever or gout, causes thrombosis and dilatation, and veins previously dilated are made worse.

Varicose veins cause a sense of tiredness, congestion, or aching. At any time they may become thrombosed, and set up inflammation. The skin, being congested, is likely upon a slight injury to develop a large ulcer which shows no tendency to heal. A small dilated vein may easily give way either through intact skin or from an extension of the ulcer. Death from hæmorrhage has often occurred, generally in a woman who has remained seated in a chair with the leg hanging down.

Varicose veins should be excised if they are increasing and prevent the patient from following his occupation, when not controlled by elastic pressure, when an ulcer has formed, or when there is danger from the vein bursting. Thrombosis is no contra-indication to the removal though a linear incision in order to save a large ulcer from forming. The presence of an ulcer may prevent the primary union of a wound in its neighbourhood; but this may be overcome by getting the ulcer clean during a rest in bed before the operation. An excision is unnecessary where the veins are small and controllable by an elastic stocking or bandage, but it is generally useless to try elastic pressure when the enlarged veins are behind or to the inner side of the knee or in the thigh. If the woman is pregnant, and there are no complications, the operation is postponed; if, however, there is danger from hæmorrhage or a septic ulcer, it is better to excise at once. Veins enlarged from obstruction to the large venous trunks of the abdomen are best left alone.

In excising varicose veins there are two important points to be observed in order to prevent recurrence—the excision of the vein at the highest point of dilatation, in the case of the internal saphena at some point in the thigh as far up as the saphenous opening, and in the case of the external saphena at its entrance into the popliteal space; and, secondly, to excise at least one inch of the dilated vein, or an anastomosis between the two ends will form around the ligature. The incisions used are of three kinds in order of frequency—vertical, semilunar, and transverse. A vertical incision an inch or more in length may be made directly over the vein or just to one side; the vein lies immediately beneath the true skin. When separated, it is drawn upon upwards and downwards, so that as much as possible shall be included between the two ligatures, and in this way tortuous veins are drawn out. A semilunar incision with a flap turned up is convenient when the veins are in a large bunch, and where a longitudinal incision would be unnecessarily long, or would have to be much retracted. The direction in which the flap is formed may be upwards or to one side, according to the best blood-supply.

Several wounds may be made in the same leg. Five wounds measuring more than 18 inches were made in the leg and thigh of a tall man for very large veins, and all healed by first intention.

Division and Ligature of Varicose Venules.—A transverse incision is convenient when the veins are small, numerous, and widespread, thin-walled and obscured by fat. The incision is steadily made as far round the limb as required, clamping the veins cut on either side until the deep fascia is exposed along the whole length of the wound. The small veins are then tied over the clamp forceps.

Rupture of a Varicose Vein.—If a patient in danger of hæmorrhage declines treatment, she should be warned to apply direct pressure should bleeding occur; and should she be alone, and not have sufficient presence of mind to apply pressure herself, she should lie at length on the ground, with the leg raised and leaning against the wall, and stay there till help comes.

In the thigh a vein may rupture subcutaneously, and form a blood-cyst.

Ulcer of the Leg.

Traumatic Ulcer.—For an ulcer to be called traumatic there should be a distinct history. Lymphangitis and suppuration are exceedingly uncommon except in the case of trivial lesions in children—a scratch, an abrasion, a blister. A traumatic ulcer, neglected either by being left without dressing, or covered with foul rags, or kept covered under a water dressing, may become inflamed, erysipelas may spread from the ulcer, phagedæna may attack it, and cause a rapid extension, or suppurative periostitis and ostitis may arise. Healing of a traumatic ulcer may be simply prevented by movement, and the collection of crusts beneath which ulceration goes on. The ulcer is treated with carbolic acid, pus and foul granulations are wiped or scraped away.

Syphilitic Ulcer.—An ulcer in a young or well-to-do man or woman, not evidently the result of injury or caused by varicose veins, can hardly be due to anything else than syphilis inherited or acquired. It is very often the only syphilitic lesion of which there is any sign in married women. Varicose veins, long standing, and slight injuries, often complicate it. Iodide of potassium and mercury, internally as well as locally, will, if the ulcer is syphilitic, quickly cause a decided improvement or a rapid cure.

Chronic Ulcer of the Leg.—Apart from the persistence of either or all of the three causes—varicose veins, traumatism, or syphilis—an ulcer becomes chronic from long standing, feeble circulation from insufficient food or other causes, neglect of dressing, induration of the edges and base, impairment of the blood-supply, want of skin to cover in the ulcer, lymphatic obstruction causing solid œdema.

Rest, plenty of good food, and careful dressing, are absolutely necessary; the induration of the edges is got rid of by pressure, by means of strapping changed every two or three days, or by an elastic bandage, changed night and morning, the bandage being carefully washed and dried. Chloride of zinc, in lotions of increasing strength, may be applied so as to increase the vascularity of the base. When the ulcer becomes healthy, the granulations are scraped away, and the base grafted with epidermis. The patient must rest until the new skin has become well established, and if not kept clean it will be apt to give way again.

Lymphatic obstruction causing œdema may be relieved by massage and elastic bandaging; but when there is a permanent thickening of the skin and subcutaneous tissue of a rugose character, producing the condition known as pseudo-elephantiasis, amputation is the only treatment applicable.

Ulcers due to a Nerve Lesion—Perforating Ulcer.—These ulcers arise in consequence of neuritis and nerve degeneration, in diabetes and chronic renal nephritis, as a result of an injury to the sciatic nerve and its branches, or in consequence of the malformations of the spinal cord which accompany spina bifida, also from degenerative changes taking place in the spinal cord in the course of locomotor ataxia, syringo-myelia, etc.

The ulcers form at any part, but especially on the plantar aspect of the foot near the great toe. Ulceration extends down to the bone, whilst the edges of the ulcer are thickened, so as to resemble a corn. From such an ulcer may spread septic complications, producing extensive necrosis of bone.

The ulcer is dressed antiseptically; the thickened edges may be pared away; a sinus is scraped, or freely excised, carious bone gouged away, after which the wound is dressed from the bottom. Healing has followed nerve-stretching—it is not clear why. Amputation may be necessary for extensive septic complications.

Incision and Excision of the Ankle-Joint.

The ankle-joint is a hinge joint in which there is no lateral movement. It is important, therefore, to preserve the lateral ligaments of the joint in all operations. The synovial membrane when distended can only bulge forwards, or backwards on either side of the tendo Achillis.

Disease of the ankle-joint is not common. Acute and chronic synovitis is caused by injury, and the latter may be owing to rheumatoid arthritis or locomotor ataxia. Pyæmia from a distant source may cause suppuration, and the joint may be incised by a longitudinal incision over the most prominent swelling, whilst avoiding the bloodvessels.

Tubercular Disease of the Ankle generally commences in the neighbouring bones, astragalus, os calcis or tibia, and by extension the synovial membrane becomes affected. Pain and swelling occur with some heat in a young patient, and after an interval there is suppuration and the formation of sinuses.

The joint is first of all fixed in plaster, the foot being at right angles to the leg, and a patten put under the opposite boot. The patient then walks on crutches without touching the ground with the affected foot. Or the patient may be supplied with a kneeling-pin; the bent knee rests on a cushion, and the front of the leg upon a grooved projection behind. Then the patient can walk without crutches, keeping the ankle at rest; when, however, the tubercular disease progresses, all the disease must be removed. The ankle-joint can be exposed from any aspect by an anterior, antero-lateral, lateral, bilateral or posterior incision. The anterior incision, if transverse, involves the division of all the tendons in front of the joint, and these must be carefully reunited. The lateral incision sacrifices the lateral ligament, leaving the joint weak and liable to lateral movement on that side.

The posterior incision is useful, for not only does it avoid injury to the lateral ligaments, but it is also suitable if it be necessary to extend the operation further.

The circulation being controlled and the ankle held at a right angle, the incision is carried from just below one malleolus to the other, round the heel behind the point upon which weight is borne in standing. The incision goes only through the skin at the side, but down to the os calcis in the middle. The os calcis is then cut through with a saw, so that the portion of the bone which projects behind the astragalus is separated. The foot is now forcibly flexed until its dorsal aspect comes in contact with the anterior surface of the leg; this overflexion really relaxes the lateral ligaments, so that the ankle-joint is fully exposed by simply cutting through the os calcis. The whole of the synovial membrane can be removed as well as the cartilage from the tibia, fibula, and astragalus. If the disease has extended no further, the end of the os calcis is fixed by pegging, so that the union which has to take place is that of the two bony surfaces of the os calcis. No ligaments, tendons, or bloodvessels are damaged; but disease may be found in or between the tibia and fibula, and along tendon-sheaths; the astragalus may have to be excised, or tubercular disease may affect the whole of the os calcis. If all disease is removed, the pockets wiped out and filled with iodoform, a good joint may still be obtained. But when the ends of the tibia and fibula have to be sacrificed, and the os calcis and astragalus removed, the anterior end of the foot may still be fixed to the end of the leg, so that the patient walks on the ball of the toes, or, as a last resort, a Syme's amputation may be done. For all these operations the posterior incision into the ankle-joint is the best.

Incision and Erasion for Tubercular Disease of the Foot.

Tubercular disease may begin in a tendon-sheath, or in a joint, or in a bone. Slight pain, continuous, and increased on pressure, in a young patient, will lead one to suspect tubercular disease. This may be proved by fluctuation being found, or upon an exploratory incision. A tendon-sheath may be locally affected, or many tendon-sheaths may be involved, as in the case of the compound palmar ganglion. A fluctuating swelling, when incised, may be found to expose a joint, or to lead into the centre of a soft and carious bone. In the early stages the bone is found simply softened, but in later cases microscopic evidence of the tubercle can be obtained. Early erasion is the one treatment. If allowed to extend and form sinuses, the tubercular process becomes complicated by pyogenic organisms, and although incision and the thorough scraping or gouging away of all diseased bone may even then be successful, yet the prognosis is not so good. In extensive cases, unless life is threatened by exhaustion, thorough erasion or partial resection is tried before resorting to amputation.

Excision of the Os Calcis is generally required for tubercular disease confined to the bone and its articulation with the astragalus. A horizontal incision is made round the heel immediately above the sole, commencing from the inner side behind the sustentaculum tali, so as not to injure the plantar vessels and nerves, and ending at the calcaneo-cuboid articulation. The flap thus outlined is raised, and, after taking away the bone, sutured back in place. Sutures may be put in the tendo Achillis to fix it to the astragalus and to the sole of the foot. The scar is not pressed upon; the ankle and astragalus sink down a little, and the patient is flat-footed. There may be some tendency to inversion, which must be corrected.

Excision of the Astragalus is done for dislocation, for tubercular disease, and to rectify club-foot. The incision is made on the dorsum parallel to the tendons, which are retracted. The tibia and fibula sink down to the os calcis, so that the foot is shorter and flatter, but otherwise good.

Acquired Deformities of the Big Toe.

Many of the diseases of the big toe are due to ill-fitting boots, especially from the prevailing fashion of bringing the boots to a point in the middle of the foot. If a pointed toe be desired, it should be to the inner side, covering the great toe; or if in the middle the boot must be by so much the longer. The boot must be straight along the inner side of the foot as far as the point of the great toe, whatever else be its form. The changes produced in the great toe have remote results, such as an impaired gait from the loss of all spring and enforced walking on the heels; also the inability of women to walk any distance, hence their tendency to get fat; in men flat-foot and a shuffling gait follow. The following deformities are practically all due primarily to ill-fitting boots, although some slight injury is often considered the exciting cause:

Ingrowing Toe-nail.—The nail as it grows naturally becomes dry, hard, and flattened out. Lateral pressure on the side of the nail produces inflammation and thickening, or an ulcer discharging more or less foul pus forms between the soft parts and the nail.

The toe-nails should always be cut square, and the angles never rounded off. Square-toed boots, sufficiently long and broad, along with the insertion of some dressing beneath the edge of the nail, so as to raise it, may suffice. Under anæsthesia, shaving off the thickened soft parts, wrenching off the nail, or cutting down the middle and removing only one side will result in cure if the patient wears suitable boots. Recurrence may ensue either from the patient continuing the same shape of boot, or because the condition has lasted so long that the nail-bed itself has become deformed. In the latter case the whole of the nail-bed must be completely dissected off from the ungual phalanx, so that no more nail can form. The matrix extends for $\frac{1}{4}$ inch or more beyond the fold of skin at the base of the nail. If there has been much suppuration, the ungual phalanx is also excised.

Subungual Exostosis.—A painful swelling forms beneath the nail and raises it in the middle, whilst the two sides remain free. The only treatment is a complete excision of the ungual phalanx with the nail and nail-bed, using the plantar surface as a flap. Partial operations are followed by recurrence, or by a painful stump, both of which the complete operation avoids. The operation must be done as early as possible, especially in young women, to avoid an extension of pain, and the origin of functional neurosis.

Hallux Valgus.—The great toe is gradually displaced outwards, so as to produce a partial dislocation to the side at the metatarso-phalangeal joint. At the same time the head of the metatarsal bone becomes covered with thickened tissue—a bunion. In this thickened tissue a bursa forms, containing inflammatory exudation, and causing intense pain. Suppuration follows, which, by spreading to the joint, may set up necrosis.

In early cases broad-toed boots, the insertion of a strip of lint between the first and second toes, the wearing of a stocking with a separate compartment for the great toe, the application of a splint at night which draws on the great toe by an elastic band, may end in bringing the toe back to its position.

In more advanced cases such treatment is useless, owing to the alterations which have taken place in the joint surface, and the tendency of the long extensor to pull the end of the toe further outwards when once a deviation in that direction has arisen.

Excision of the head of the metatarsal bone, or of the phalanx in addition, or simply osteotomy, may be done, so as to put the toe straight and allow the tendons to pull in the long axis of the bone. At the same time the bunion is excised.

When suppuration and necrosis have occurred, amputation becomes necessary, the head of the metatarsal bone being if possible retained.

Hallux Rigidus, or the Stiff Toe Joint of Adolescence.—In young men pain in the great toe joint sets in, the joint becomes more and more fixed and painful, and the bone tends to be flexed into the sole of the foot. It is a subacute arthritis of the joint, ending in adhesions.

Three causes take part — traumatism, such as frequent injuries at football, boots cramping the big toe, and a tendency to flat-foot. The toe is forcibly flexed and extended, upon which small adhesions are felt to give way. This free movement must be continued, especially by tiptoe exercises, which will also improve the flat-foot.

Corns.—These are due to ill-fitting boots, and to the neglect to cut them carefully. A bursa may form beneath the thickened epidermis, causing intense pain, going on to suppuration. A suppurating corn is, in a patient affected by a nerve lesion, the site for the commencement of a perforating ulcer. A corn cut deep enough to bleed may in an aged, diabetic, alcoholic, or nephritic patient be the exciting cause of gangrene. A suppurating corn should be excised.

Hammer-Toe.—A toe, especially the second one, as being the longest, is cramped and doubled up, either by the shortness of the boot or by the great toe being pushed out over it. As a result, the anterior and two lateral ligaments shorten, and fix the joint in the flexed position. The tendon also gets shorter after some time.

Forcible straightening may do for early cases; subcutaneous division of the lateral ligaments or resection of the joint is tried for more advanced cases; it often happens, however, that relapse occurs, and then amputation removes a structure of no special advantage to the foot.

Flat-Foot, or Talipes Valgus.

Flat-Foot, or Talipes Valgus, may be congenital or paralytic in origin. Suitable mechanical supports are required, but very rarely operative measures.

Acquired Flat-Foot is due to a stretching of the ligaments and tendons on the inner side of the foot, especially the calcaneo-scaphoid ligament. It may be the direct result of a sprain, or be gradually developed by long standing, in combination with a poor muscular development. It may be secondary to knock-knee or to a badly-united Pott's fracture, the weight of the body being unduly thrown upon the inner side of the foot. It may also be inflammatory in origin, gonorrhœal, gouty, or rheumatic. Pain is felt after standing, and stiffness after resting; the pain may be felt over the arch of the instep towards the toes, or in front of the ankle. The patient loses all spring, can only walk a short distance, and gradually he is unable to raise himself on tip-toe, and the calf muscles become small and soft. The great toe joint becomes stiff. The feet sweat profusely and stink.

The deformity is divisible into three stages: In the first, when the patient bears weight, the arch sinks, but the foot can be easily inverted so as to rest on the arch. It is treated by local massage and liniments, by practising tip-toe exercises—*i.e.*, by walking or repeatedly rising upon tip-toe for at least five minutes three times a day, by standing on the outer edge of the foot when standing is absolutely necessary, by wearing broad-toed, low-heeled, well-fitting lace boots, and by improving the general muscular nutrition, not only of the leg, but of the body generally. For the sweating, antiseptic washes and belladonna liniment are required, with special cleanliness and frequent changes of socks. Bicycle-riding is of advantage for those who cannot or who will not walk.

In the second stage the arch is lost, the scaphoid is more prominent, and the head of the astragalus has sunk down behind it. The foot has become rigid, due to the adhesions which have formed.

The foot must then be well wrenched under anæsthesia until it can be thoroughly inverted, in which position it is put up in plaster for two or three weeks. And as soon as he can, the patient is encouraged to commence the tip-toe exercises. It frequently happens that more than one wrenching is required. A week or ten days after the first, the adhesions will give way much more easily, having undergone some inflammatory softening in the meantime. Wrenching, massage, and exercises are sufficient for most cases of flat-foot.

A third category, in which there is bony ankylosis, have been operated upon by cutting out a wedge-shaped piece and bringing the surfaces together, leaving the patient with an arch. Such operations have been successful; failure has also attended them. The displaced scaphoid or astragalus may give rise to such pain that the very fact of removing the prominence affords relief, and allows the patient to walk, although the foot is permanently flat.

Another operation of doubtful expedience is supra-malleolar osteotomy and forced inversion.

Pes Cavus.

The heads of the metatarsal bones are brought nearer to the heel, the metatarso-phalangeal joints are overextended (dorsiflexed), the proximal interphalangeal joints flexed to a right angle. The extensor tendons and the plantar ligaments are shortened, and resist extension. The causes are two: (1) paralytic, (2) acquired. There may be paralysis of the calf muscles, or merely an inability to extend (dorsiflex) the foot beyond a right angle with the leg, owing to the contracture rendering the tendo Achillis tense; or the foot may be permanently flexed by a contraction of the flexors.

Pes cavus may also be produced by compression of the feet. The most marked is seen in the case of Chinese ladies, but slighter forms are caused in children by boots which are not long enough. The origin of the complaint is often attributed to a corn, but a corn is merely the earlier effect of the ill-fitting boot.

When the foot is brought to a right angle with the leg, and the tendo Achillis becomes tense, tenotomy will relieve, especially if roomy boots of good length are worn. For more advanced cases, division of the plantar ligaments, division of the tendo Achillis, wrenching, and massage are required.

Club-Foot, or Talipes Varus.

It may exist alone, or with more or less of talipes equinus, shortening of the calf muscle, and tension of the Achilles tendon. The cause is commonly congenital, and is attributed to malposition *in utero*, the foot remaining in the earlier position of the mid-uterine period. This is scarcely an explanation. Evidence of failure of spinal cord influence has also to be sought for. Undoubtedly this condition is present in cases of spina bifida. Club-foot may be acquired after birth, following upon paralysis of the extensors and peronei.

If commenced in a baby, a club-foot can be easily everted; the mother may herself manipulate it, or the foot is gently everted, and put into plaster of Paris; the plaster is changed, and more eversion made. When the foot has been thoroughly everted, the tendo Achillis is divided, and the foot immediately flexed up to a right angle with the leg. For a time, the plaster, then massage, and passive movement are required, the mother watching against any tendency to recoil. This tendency may be prevented by a suitable form of Scarpa's shoe, and later by boot and irons. Worse cases require division of the plantar fascia, and of the posterior tibial tendons also.

It cannot be too strongly insisted upon that, except in marked paralytic cases, when the foot is bent up parallel to the leg or quite loose, early wrenching, combined with division of the Achilles tendon, will cure nearly all cases, especially when the tendency to recur is guarded against.

Club-foot when seen in older cases should be treated on the same lines. The wrenching is more severe, and has to be repeated under an anæsthetic, and the division of ligaments and tendons is freer. Yet, with perseverance, cases are cured with a fairly useful plantigrade foot.

Bone operations are done for club-foot, but they are still of doubtful expediency—first, as interfering with the finer movements of the foot, and reducing it to a rigid object; and, secondly, from the tendency to relapse.

The operations are: (1) An internal incision, going down to the bones through all the ligaments and tendons, and wrenching outwards; the large internal wound may be covered in by skin-grafting. But it may be pointed out that this gap is filled in by scar tissue, which is always tending to contract and reproduce the deformity. (2) Tarsectomy. A wedge-shaped piece of bone is taken from the outer side; some of the thickened skin upon which the patient has walked may be excised. This produces a shortened, rigid foot, fixed at a right angle with the leg, a stump ornamented by toes. (3) Excision of the astragalus. The end of the tibia and fibula sink down and articulate with the os calcis. The foot can thus be considerably everted, with a loss in length, but retaining some mobility. (3) Supra-malleolar osteotomy and turning the foot outwards is rarely of use.

Subcutaneous Division of Tendons and Ligaments in the Neighbourhood of the Ankle-Joint.

Contraction of the Tendo Achillis.—Owing to a short tendon, the foot is kept extended, and cannot be dorsiflexed, even in the slightest form, beyond a right angle with the leg. The patient is forced to walk on the toes, hence cramp, pain, corns, bunions, or he walks on the outer side of the foot and ankle, or even on the outer part of the dorsum and toes with the foot inverted. The hamstring tendons also shorten.

The causes are numerous: Congenital, from ill-development of the spinal cord, from infantile paralysis in the young, and from various other paralyses in older patients, affecting the spinal cord and sciatic nerve. It may be acquired by ill-fitting boots, which give rise to corns and sores. Injuries dividing the nerves, or a burn causing extensive scars, or a fracture, especially Pott's fracture, in which the displacement is not fully reduced, lead to the contraction. Simple confinement to bed for a long time, so that the foot is kept extended by the pressure of the bedclothes, may produce it.

The slightest form is often called right-angled contraction; the foot cannot be dorsiflexed beyond a right angle. Attention is drawn to it by difficulty or pain in walking, development of hammer-toe, corns, pes cavus, etc.

The contracted tendo Achillis cannot be stretched; even in an infant it must always be divided.

Division of the tendo Achillis is done under anæsthesia, by rendering it tense, puncturing with a tenotome on the inner side, and cutting backwards, guided by the thumb and fingers on the skin behind and to the outer side. After making the puncture, the sharp-pointed tenotome may be exchanged for a blunt-topped one. It must be remembered that the tendon is cylindrical, not flat, or the most anterior fibres may not be cut. The cutting must be gently done, so that sudden yielding shall not let the knife injure the skin; and the tendon kept tense, so that its gradual division can be more easily recognised. The foot is fully flexed at once, the ability to do so indicating the complete division of the tendon.

The Posterior Tibial and the Flexor Longus Digitorum require division for inversion of the foot. The subcutaneous division is made just behind the tibia, above the ankle-joint.

The Peronei Tendons are divided just above and behind the external malleolus for eversion of the foot.

The Plantar Fascia is divided subcutaneously on the inner side of the instep for club-foot, but its more complete division, including that of the ligaments of the tarsal joints, can be better done through an open incision.

A pad of gauze is applied over the puncture as the knife is withdrawn, and firm pressure made with the thumb; the foot is then surrounded by cotton-wool or a bandage, and a plaster applied. Some bleeding often occurs, but is not of any importance, although it is not unlikely that the posterior tibial artery is often injured. A traumatic aneurysm has been known to form, but has been easily cured by direct pressure.

Tendon-Grafting and Transplantation for Paralytic Deformities.

The functions of paralyzed muscles in children may be partially replaced by connecting their tendons with neighbouring active muscles. Thus, the tendon of the extensor longus hallucis may be connected with the paralyzed tibialis anticus or extensor communis digitorum tendon, or *vice versâ*. The function of the paralyzed peronei may be partly regained by connecting their tendons with the gastrocnemius.

CHAPTER XLIII.

SURGERY OF THE SPINE.

The Spine.

The spinal column is concerned in maintaining the erect posture and in protecting the spinal cord. When the spine itself is alone involved, there is much pain from displacement, from stretched ligaments, and from pressure on posterior nerve branches; but when the cord and membranes are also involved, the condition is more serious, and death may ensue from inflammation and degeneration spreading up the cord, or from secondary complications—bladder and kidney trouble or bed-sores.

Sprain of the Spine.

Injuries attended by a violent jar to the spine or by excessive bending give rise to symptoms which have to be distinguished from fracture and dislocation, or from injury to the spinal cord itself. It may follow any kind of accident, and there is apt to arise a nervous instability, whether from the fright, or from anxiety as to future disablement, or as to monetary compensation, and sometimes from downright malingering; and then the patient presents a variety of symptoms, but no sign of organic lesion other than that of stretched and inflamed ligaments. The diagnosis of sprain therefore rests upon the absence of any sign of a fracture and dislocation, or lesion of the spinal cord. There is severe pain on movement; and if there is hyperæsthesia at the site of the lesion, it may likewise be found at distant spots. Concussion of the spinal cord and hæmorrhage beneath the meninges depress the functions of the spinal cord. In nervous disorders, superadded to sprain, the reflexes, etc., are exaggerated.

The treatment consists of rest for a few days after the accident, then the resumption as soon as possible of active employment and outdoor exercises, to which may be added change and tonics. Prolonged rest allows adhesions to form, and further depresses the general and mental condition of the patient.

An exploratory incision may be made for persistent well-localized pain, in the hope of relieving tension, removing a spiculum of bone, or freeing a nerve-twig from scar tissue.

Coccygodynia.—This is a sprain of the coccyx, occurring in women after slight injuries, generally falls, less often from the pressure of the head during labour. The pain, both in amount and duration, is out of proportion to the accident. Pain is caused by sitting, during defæcation, and on touching. No displacement, either forwards or backwards, is present. When the symptoms persist for months. it is clear that the affection is a traumatic neurosis.

The treatment consists at first in anodyne applications, such as belladonna, opium, or aconite; the use of a hollow cushion; the administration of aperients and tonics. If the pain continues unrelieved for six months or so, the coccyx may be excised, the operation being treated as an experiment; for although it is likely to benefit the patient, the neurosis may return. The coccyx is exposed through a longitudinal or transverse incision behind the anus, and is cut away from the sacrum by bone forceps.

Fracture and Dislocation of the Spine.

It is the body of a vertebra which is chiefly involved in a fracture, but it may extend to the arch. Fracture of a spine or transverse process apart from the body of a vertebra does not occur. A dislocation, uncombined with a fracture, is only met with in the cervical region; it is elsewhere prevented by the shape of the articular processes.

The Atlas Vertebra.—Complete dislocation of the occipital condyles from the atlas is immediately fatal from injury to the spinal cord at the junction with the bulb. A partial dislocation caused by blows or falls may simply press on the spinal cord, and cause incomplete paralysis, rigidity of the head, and irregularity of bony prominences. Reduction has been successfully carried out by extension on the head, counter-extension on the shoulders, and direct pressure upon the displaced bone.

The Axis Vertebra.—Displacement of the axis upon the atlas takes place from destruction of the transverse ligament, especially by tubercular disease. The odontoid process is released, and presses back the cord against the hinder edge of the foramen magnum. If the ligament gives way rapidly, sudden death may occur; if slowly, the lateral columns may escape, but gradually paralysis of voluntary movement and sensation slowly increases, with dyspnœa, until finally death occurs from respiratory paralysis.

The only treatment suitable would be laminectomy, to relieve the compression of the cord against the neural arches and foramen magnum.

Signs of Fracture and Dislocation of the Spine.

The signs are fixation of the vertebræ, displacement of the bodies as indicated by the altered relation of the transverse and spinous processes, together with symptoms referable to the spinal cord.

If the spinal cord be completely divided, there is entire loss of sensation and motion, including reflexes, in the parts supplied by nerves rising from the spinal cord below. There is pain at the site of fracture, and this is referred to the terminal ends of the nerves arising from the cord immediately above the lesion, and which are more or less lacerated or compressed by the injury.

In the cervical region there may be a fracture without dislocation, and then there will be increased mobility and crepitus at the site of the injury, although it is unwise to make any forcible examination, for fear of damaging further the spinal cord.

The spinal cord may be simply compressed by the bone or by blood-clot, or bruised or only partly lacerated. The paralysis below will then be incomplete, the knee-jerks retained or even exaggerated, and there will be a tendency to improvement according to the injury.

Fracture and Dislocation in the Cervical Region.—At or above the level of the fourth vertebra, complete compression or division of the spinal cord is immediately fatal; but when the injury is below the fourth, the diaphragm continues forcibly in action. With each contraction the abdominal contents are pushed sharply downwards and forwards. If the spinal cord has been completely divided, there is little hope of life being prolonged beyond a day or two. The lungs are imperfectly expanded, and become œdematous; the patient cannot cough, becomes more and more blue, and dies from this cause.

Fracture and Dislocation in the Dorsal Region.—Whilst there is paralysis of the legs, and of the sphincters of the bladder and rectum, power is retained in the arms and in the upper intercostals according to the level of the lesion, and therefore inspiration is more perfect, although the patient cannot make any forced expiration. Life may be prolonged indefinitely, provided that the patient can obtain good nursing.

Fracture and Dislocation in the Lumbar Region.—The large size of the spinal canal allows the nerves of the cauda equina to be displaced without injury, and so there is greater chance of recovery. The injury will vary according to the level; thus, the legs may be partly deprived of motion and sensation, the rectal and bladder sphincters may be involved with the upper sacral nerves, whilst erection remains owing to the upper lumbar being intact.

The patient is laid upon a hard mattress, and if there is a fracture-dislocation, extension is made on the head and heels of the patient, along with direct pressure by the surgeon's hands, so as to reduce the dislocation.

If it is desired to fix the cervical vertebræ, the head, neck, and shoulders are included in plaster of Paris bandages, strips of metal being inserted behind and at the sides for stiffening. The face is left free, and the front of the neck not pressed on. This may be afterwards exchanged, when the patient gets up, for a poroplastic felt apparatus, which includes the shoulders and neck, and has a high collar in which the head and chin rest.

If the fracture be in the dorsal or lumbar region, the thorax and pelvis down to the trochanters must be fixed by plaster of Paris or poroplastic felt. A plaster of Paris jacket may be applied, the patient being supported meanwhile by assistants, or the plaster may be hindered from setting quickly by adding gum mucilage: Plaster of Paris, 1 pound; gum mucilage, 1 ounce; water, 8 ounces. A number of strips of muslin are cut of a length to encircle the body, and laid on a mackintosh sheet spread on the bed after being dipped in the plaster. The strips must overlap, and be about six layers thick. The patient is then lifted and laid on the bandages, having on a flannel vest without sleeves, tied with tapes over the shoulders. The strips are then folded over, and plaster is rubbed in to make all smooth. The urine has to be regularly drawn off at least four times a day to prevent retention. The glans penis or vulva must be washed, and then a soft catheter which has lain in 5 per cent. carbolic acid is passed.

Complications.—Retention and the decomposition set up by a septic catheter cause cystitis, and so pyelitis, calcareous deposits, pyuria, and death. It is best prevented, but when the urine has become alkaline the bladder must be frequently washed out. The bowels are kept regularly open, and the rectum free of scybala by enemata, or by removing fæces with the finger or handle of a tablespoon.

Bed-sores are avoided by keeping the patient free from contact with urine and fæces, and by constantly washing with soap and water. The plaster of Paris is not kept on longer than a fortnight or so, lest sores should form beneath. After its removal, constant washing and turning the patient on to his face may avoid their recurrence. Bed-sores which extend gradually exhaust the patient, or prove fatal, by extension to the spinal meninges.

Wounds of the Spinal Cord.

A wound which penetrates the meninges is shown by the escape of cerebro-spinal fluid. The cord or nerves may be injured by a puncture and by the blood-clot extravasated, or may afterwards suffer from septic inflammation.

If due to a clean instrument, the wound is simply dressed. If inflammation ensues, it may be proper to enlarge the wound and drain it. If caused by a foul instrument, or if particles of clothing or dirt have been driven in, the wound must be thoroughly cleaned, after enlarging it. The cerebro-spinal fluid which escapes should soak into a handful of boric acid powder, so that no decomposition shall ensue and induce a spread of septic inflammation inwards.

Spina Bifida—Fissure of the Spine.

This is a congenital malformation, due to the absence of one or more of the neural arches and spines, in consequence of which the skin and the meninges remain in direct contact, or the skin may be absent over the most prominent portion, and only the transparent dura covers the spinal cord.

Although in monsters and infants, which do not long survive birth, the spina bifida may be of any extent, the malformation is confined to one or two vertebræ in those children in which any question of surgical treatment arises. It is generally seen in the lumbo-sacral region, although cases have been treated in the cervical region.

There are three clinical forms.

1. **Spina Bifida Occulta.**—A hollow process of dura mater extends back to the skin, but is not markedly distended with fluid. Instead, there is, in the middle line of the lumbo-sacral region, a nævus or pigmented patch of skin, a bunch of long hairs, a dimple of skin, a fistula discharging cerebro-spinal fluid, or this hollow process may be placed in the middle of a fatty tumour, a nævo-lipoma, or be connected with a dermoid cyst containing hair. The fatty tumour may grow inwards into the spinal canal, and cause increasing pressure symptoms, or, conversely, develop in the spinal canal at first. Instead of fat, the tumour may consist of fibro-

cystic or scar tissue. This condition may exist alone, or be accompanied by evidences of imperfect innervation of the lower limbs and bladder, such as club-foot, perforating ulcers, muscular paralysis and atrophy, incontinence of urine. The search for an explanation of these conditions may lead to the discovery of the spina bifida occulta.

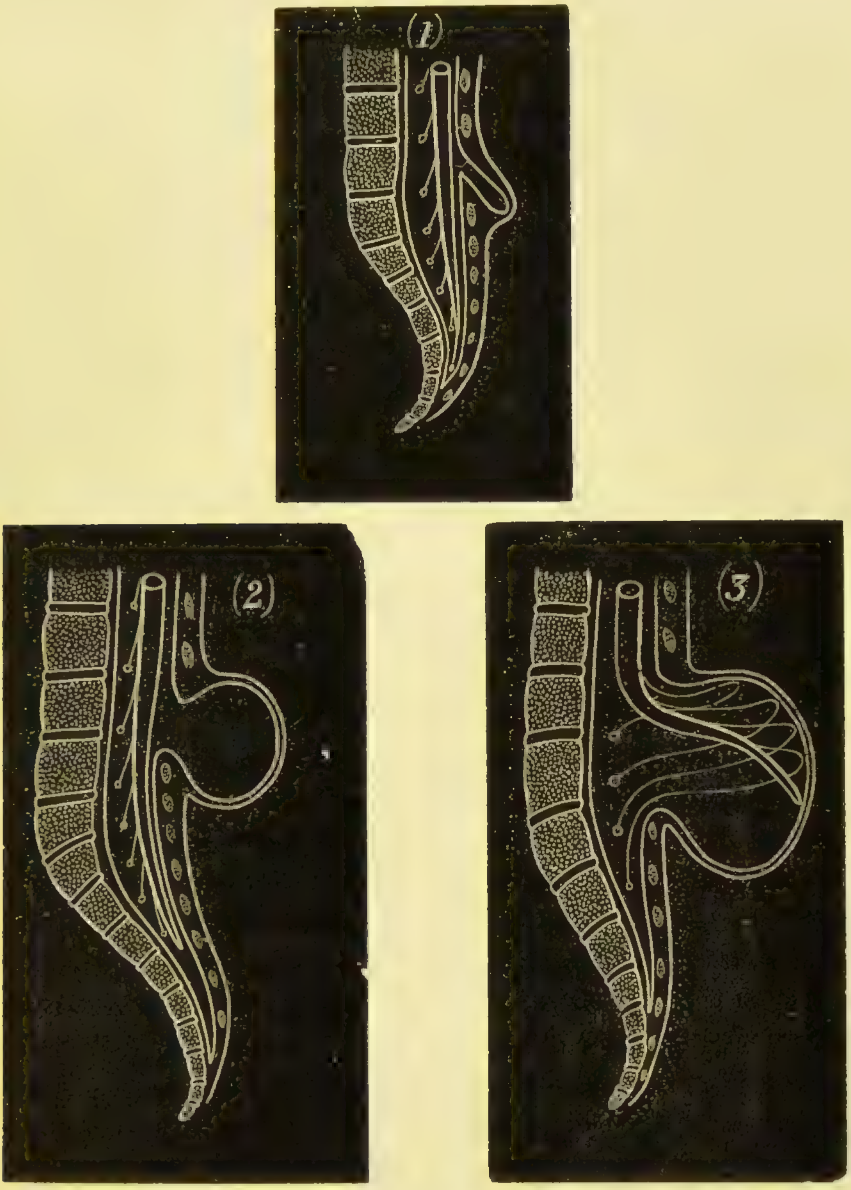

FIG. 110.—SPINA BIFIDA.

(1) Spina bifida occulta. (2) Meningocele. (3) Meningo-myelocele.

An exacerbation of symptoms may arise by the spread of inflammation from the exterior through this hollow process, or by the growth of the tumour within the spinal canal.

A spina bifida occulta should, therefore, be treated by excision; the base of the process of the meninges must be most carefully ligatured before any of the distal portion is cut away, and the cauda equina cleared of all fibrous, fatty, or scar tissue. If the meninges are not closed by ligature, then this must be done by suture, or fatal septic inflammation is likely to spread from the wound inwards. If the removal be done early in life, improvement in the paralysis may be hopefully looked for.

2. **Spinal Meningocele.**—It forms a globular swelling in the middle line, generally of the lumbo-sacral region. The skin is seldom quite normal over it. At the posterior pole there may be one of the conditions described as spina bifida occulta, or the skin may be thinned so that the tumour is diaphanous, or may be absent in part or wholly from the projecting tumour. When viewed by transmitted light, no bands are seen in the tumour. When the fluid is gently expressed, the unclosed fontanelle of the child bulges, and the child becomes drowsy. On relaxing the pressure the tumour refills. The tumour shows cardiac and respiratory pulsations, and an impulse on coughing or crying. It is made more tense by elevating the child's head, and the tension becomes less when the head is lowered below the trunk. By gently expressing some of the fluid, the size of the opening in the spinal column can be made out. It is liable to be complicated by hydrocephalus and wasting, which progress. Other deformities may be present, such as hare-lip. Paralysis of the legs and incontinence of urine may be absent, or may gradually develop, indicating an extension of pressure on the spinal cord.

Excision of the sac and suture may be demanded, on account of rupture, or threatened rupture, whether at birth or later. If possible, the tumour is protected from inflammatory complications by good nursing, and an operation is delayed until the child is a year or more, to see whether hydrocephalus will supervene. Increasing hydrocephalus contra-indicates the operation; increasing signs of pressure at the level of the tumour are an indication for operating forthwith.

The child's head should be kept low, the buttocks and tumour being the highest point, and then but little cerebro-spinal fluid will escape ; skin flaps are raised from the sides of the tumour, and the neck of the sac being exposed, it is ligatured if narrow, or sutured if broad. Fatty or fibrous masses in the canal outside the meninges are removed, and the skin sutured completely. The wound may be sealed by collodion, the dressing covered by pink protective turned outwards, and by careful nursing the dressing kept free from urine. Primary union is almost essential; should any leakage occur, the wound must be kept covered by abundance of boric acid powder, into which the cerebro-spinal fluid can soak, whilst the head is placed low, so that as little fluid as possible may escape.

A meningocele ruptured during birth has been excised and sutured with success.

3. **Meningo-Myelocele.**—This only occurs in the lumbo-sacral region, and is much less common than meningocele. Fluid collects in the anterior subarachnoid space, and pushes out the nerves of the cauda equina, whilst the spinal cord itself ends in the dimple of the skin at the posterior pole. The nerves pushed out from the neural canal adhere to the inner wall of the sac, their distal portions returning into the neural canal, to leave by the foramina. The nerves can be seen in the sac by transmitted light, and the gap in the spinal column is larger than in meningocele.

The treatment is the same as in the case of meningocele ; the sac is separated from the skin, but owing to the nerves being in the sac, the sac has to be opened, and the nerves either separated, pushed back into the canal, or returned with portions of the sac still attached. Redundant portions of the sac are cut away ; then the meninges are carefully sutured. Finally, the skin flaps are brought over and united. If possible, the sutures in the skin should not be placed directly over those of the meninges.

Injections of Iodine for the Cure of Spina Bifida.—This treatment should not be employed. It is certain to cause the sac to burst, or to allow septic organisms to enter wherever the skin is at all thin. The inflammation set up in the sac increases the tendency to hydrocephalus, and the poisonous action of the iodine makes the marasmus worse. It never has done any good except in cases most favourable to excision, viz., where the neck is very narrow and the skin covering the tumour thick.

Curvature of the Spine.

Bending of the spine not due to injury is of four kinds :

1. *Lateral Curvature, or Scoliosis.*—Originating in muscular weakness.

2. *Kyphosis.*—A rounded posterior curve, due to changes in the vertebræ and their articulations, mainly senile.

3. *Angular Curvature.*—A sharp bend backwards from tubercular disease, but (1) may be superadded to either (2) or (3).

4. *Lordosis.*—An increase of the normal lumbar curve forwards, chiefly seen in connection with hip-joint disease and dislocation.

1. **Lateral Curvature** is a bending of the spine to one side, with rotation of the vertebræ. It typically occurs in anæmic young women owing to muscular debility and defective postures. It is apt to begin about the onset of menstruation, and is made worse by bending over desks, carrying a heavy child on one arm, and by lack of energy in maintaining the erect posture. The curve commonly begins by a bending of the spine to the left, a drooping of the left shoulder, rendering the right scapula prominent ; the left crest of the ilium and the left hip protrude. Pain varies with the rate of progress of the curve. As the condition gets worse, the vertebræ are rotated, so that the angles of the ribs on the right side are turned back and become more acute, whilst their ends in front are flattened. On the left side the angles of the ribs are straightened out, whilst their front ends are sharply curved, causing a prominence over and below the region of the heart. Secondary compensatory curves form in the cervical and lumbar region,

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having the convexity of the curve in the opposite direction, viz., to the left, whilst the heart and lungs may be displaced and impeded in their action.

But lateral curvature is not confined to girls or women, for it may be seen in weakly boys. It may be secondary to some other condition, such as wryneck, or defective eyesight, leading to a constrained position of the head. A bending of the spine to one side may be due to a short leg caused by hip-joint disease, rickety curvature, arrest of growth at an epiphysis or fracture. It may follow upon an empyema. A patient who has been cured of an empyema can, however, resist the tendency, even although the chest has greatly fallen in.

Lateral curvature is prevented by good food and open-air exercise. A bad posture should never be assumed; either the spine should be held straight and the shoulders thrown well back, or, when too tired to maintain it, the patient should lie flat on her back on a hard mattress, with the window or light at the head of the couch, so that she can read, write, or work in this position. At first she may have to lie all day, except when at meals or outdoors, and then she must hold herself straight. Gymnastic exercises for strengthening the back muscles are pursued according to the patient, but fatigue should not be occasioned.

Braces and corsets if well fitted may prove useful, but no fixed apparatus is admissible unless a curvature has been established beyond the hope of repair; such appliances, by enforcing disuse, add to the muscular weakness. Suspension by the neck with lateral counter-extension is employed; also forcible pressure and massage by the hands may be tried to overcome a rigid curve.

2. **Kyphosis.**—A rounded curve backwards is a senile change, occurring earlier in those who have worked hard, especially in carrying heavy weights. The vertebral articulations are affected by rheumatoid arthritis and ossification of the ligaments. Rapid bending may develop in the course of osteitis deformans and malignant disease of the vertebra, or aneurysm. Occasionally a kyphosis (rapid) develops in consequence of tubercular disease attacking many vertebræ

at once, especially in adults. Kyphosis is also seen in rickety, paralytic, and weakly children.

3. **Angular Curvature from Tubercular Disease.**—This generally affects children, the tendency growing rapidly less after puberty; but no age is quite exempt, and it may be met with in the aged. The disease commences in the bodies of the vertebræ, the spines and laminæ remaining free. The bodies tend to sink together, whilst the caseous material extends beyond the spine in front or backwards into the spinal canal. At any stage the patient may die of tubercular meningitis, spinal and cerebral, but not usually by direct extension.

Tubercular Disease of the Atlas and Axis.—This appears to affect one or both sides. The disease may attack the transverse ligament, and there may be slow displacement of the odontoid process, so as gradually to press the cord backwards against the posterior rim of the foramen magnum. Yet, owing to the slow progress, and to the fact that the lateral aspects of the cord are not compressed, the condition is not fatal immediately. But at any time, owing to a sudden increase of the displacement, death may happen.

The signs are, first, stiff-neck, a loss of the nodding movement between the occipital condyles and the atlas, or a loss of the rotation movement between the atlas and axis. There may be pain on pressure over the bones behind or at the sides. An abscess may form and be incised behind the upper part of the sterno-mastoid, and a portion of the atlas has been discharged as a sequestrum. The hypoglossal and spinal accessory nerves may be involved, causing paralysis in the muscles supplied.

The patient must be kept fixed on the back, without any movement of the head and neck. Extension is kept up by a chin-strap attached to a weight and pulley over the head of the bed, whilst the sides of the head are fixed by sand-bags. When signs of ankylosis have sufficiently progressed, the patient is fitted with a jacket and a high collar, in which the head is supported and fixed, and to this may be added a bar of iron ('jurymast'), reaching from the nape of the neck over the head to a strap round the forehead.

Tubercular Disease in the Cervical, Dorsal and Lumbar Regions is indicated first by stiffness of the spine and pain on pressure, or on coming down on the heels, or on tapping the head. In attempting to stoop to pick up from the floor, a child holds the spine rigid, and places one hand on the knee to support itself. As the disease progresses, an angular curvature backwards becomes more and more marked; the spine of one vertebra may be especially prominent, but the whole spine may be curved where many bodies are affected. Some lateral curvature may appear secondarily from the patient supporting himself on his elbow.

Caseous matter extends forward on either side of the anterior common ligament. If in the cervical region, it may bulge forwards the wall of the pharynx and form a post-pharyngeal abscess. A post-pharyngeal abscess due to tubercular disease of the spine is best reached by an incision behind the sterno-mastoid (see p. 244).

If in the dorsal region an abscess forms in the posterior mediastinum, it may burst into the pleura or lungs, or track downwards and point in the loin, or extend into the psoas. Attempts may be made to drain the abscess without opening the pleura, by cautiously dividing the necks of two or three ribs.

Psoas Abscess.—The caseous matter spreads into the sheath of the psoas. It may bulge backwards in the lumbar region, extend down within the sheath of the psoas muscle, and form a swelling in the inguinal region above Poupart's ligament. It may spread to the iliacus, and fill the hollow of the ilium. It may pass under Poupart's ligament and behind the vessels, and point on the inner side over the lesser trochanter. Beyond this the pus has extended down the leg to the heel.

If not treated, a psoas abscess sooner or later bursts either externally or internally into the intestine or urinary tract. The result is secondary septic infection, added to the tubercular process; the patient gradually sinks from septic exhaustion. Only rarely, after a sequestrum has been discharged and ankylosis of the spine taken place, is there spontaneous recovery. The disease may be bilateral.

As soon as a psoas abscess is diagnosed, it should be incised through the loin, the cavity well washed out, any spiculæ of bone removed from the anterior surface of the vertebræ, and then an iodoform emulsion in glycerine injected. The wound may be sewn up at once, especially if no septic condition has been present before the operation, or the cavity may be drained for a few days, especially if large and multiloculated.

Even when the abscess has extended into the thigh the lumbar opening is best. It is the most dependent whilst in bed, and septic infection can be kept from spreading up the drain-tube. If the disease of the vertebræ stops and ankylosis ensues, a cure may follow.

When a psoas abscess has burst, or been opened and allowed to become septic, the treatment is attended with much less success. A free lumbar opening is made, and the cavities well irrigated and sinuses scraped. After long rest recovery may ensue.

Treatment of Angular Curvature.

In all chronic spinal cases fresh air is of the greatest importance, the patient being wheeled out on a spring carriage, lying on a mattress, and lifted from the couch to the carriage on the mattress. An angular curvature may be thus prevented by rest.

In order that a child may get about, a stiff jacket must be applied either of plaster of Paris or of poroplastic felt. In applying the jacket, slight extension should be made on the spine. A patient may be suspended from a tripod by a strap beneath the chin and round the nape of the neck, being just raised on to tip-toe. He may be laid across two stools face downwards, one stool supporting the pelvis, the other the head resting on the folded arms, whilst the hand of an assistant supports the stomach. Or the patient may be placed, face downwards, in a canvas hammock; the hammock is slung, and the plaster applied, so as to include the hammock. When the plaster is dry, the strip of canvas is unfastened at one end and drawn through. Beneath the plaster a thick woollen vest is put on, which has no sleeves, but is simply tied above the shoulders. The vest can then be changed by attaching a clean one to it; the withdrawal of the dirty vest draws the clean one into position. A pad of wool may be placed over the angle, and another over the stomach, to give room for distension. No jacket must be tight enough to impede the respiration.

A poroplastic jacket, although more expensive, lasts longer, is light, can be put off and on, and it can be softened over the angle.

Forcible Straightening of an Angular Curvature.—A recent curvature may be greatly lessened, or even removed, without fear of causing paralysis or of aggravating the disease of the vertebræ. The removal of the curvature favours the treatment directed towards obtaining permanent ankylosis.

The patient's bowels should be moved freely, and then, under anæsthesia, extension is steadily made on the head, arms, and legs. Meanwhile the surgeon makes steady pressure on the curve. A plaster jacket or a special splint is put on, so as to fix the head, neck, and trunk.

Pressure on the Spinal Cord may be indicated by pain, spasm, or paralysis, and if prolonged it may cause permanent degeneration of the spinal cord. It may be due to the angular curvature, the cord being compressed against the laminæ. Prolonged rest and extension in bed are often very successful. If there is no improvement, removal of the laminæ is indicated.

Paraplegia may ensue without any corresponding deformity of the column. Persistent pain, and especially the appearance of pus on either side of the spine, indicates an involvment of the spinal canal which incision and erasion can alone relieve.

Aspiration of the Spinal Meninges.

This has been employed for diagnostic purposes. The needle of a small aspirating syringe can be passed forwards between the lamina of the fifth lumbar vertebra and the upper edge of the sacrum on either side of the spine, and pushing the needle forwards, upwards, and inwards for about $\frac{3}{4}$ inch in a child, and for $1\frac{1}{4}$ inch or more in an adult, cerebrospinal fluid is drawn off. In this way positive evidence of tubercular meningitis may be found. The removal of fluid by an aspirator, whether for hydrocephalus, hydrorachis or for a spina bifida, is useless. The fluid quickly re-collects. If much fluid be rapidly removed convulsions may be caused.

Laminectomy, or Removal of Neural Arches.

The patient is placed on the side, or semi-prone, or even prone, if no difficulty occurs with the breathing. He is kept very warm. The more common incision is a median longitudinal one, but the objection has been raised that the scar is afterwards subjected to much pressure when the patient lies on the back. The incision may be made transverse, or a semilunar flap may be turned up. The muscles are rapidly divided on each side of the spine and retracted, transverse notches being made in them if more room is wanted. Sponges are pressed into the sides of the wound to stop the free hæmorrhage which occurs. One or more spinous processes are cut off; then a lamina is cleared and trephined, unless the blade of the bone forceps can be got underneath. After one lamina has been removed, others can be more easily cut away. The greatest care must be taken that the blade pushed under the lamina does not press upon and injure the spinal cord; and the same applies to all the other manipulations.

Laminectomy for Injury.—Primary laminectomy for fracture and dislocation is very unlikely to be successful, owing to the shock already caused by the accident. The same applies to bullet wounds. There must be clear signs of displacement of one or more vertebræ, which cannot be reduced by manipulation, and also signs of complete paralysis below. Even then it will be better to delay until the shock of the accident has passed away. Meanwhile, a skiagraph of the bones or position of the bullet may be obtained. Where there is great mobility, the spine has been fixed by silver wire sutures. Laminectomy may be later on considered where deformity is present, when the improvement after the accident has come to a standstill, leaving the patient helpless, yet with signs that the spinal cord has not been divided. Pain, spasm, increased knee-jerks, or spinal cord degeneration, may serve to localize the lesion and indicate an operation. The cord may be found compressed against the laminæ; a fragment may be found pressing upon the spinal cord, and be elevated and removed. The sheath of the cord may be thickened by scar tissue, and this may be dissected off. The meninges are not opened, except for very clear indications of blood-clot or its results within, and are afterwards carefully sutured.

Laminectomy for Tubercular Disease.—This operation is indicated when there are signs of increasing pressure with much angular curvature; also when pus appears on either side of the spine, and is found to extend into the spinal canal; or when there is excessive deformity, with progressive degeneration of the spinal cord which has not been relieved by prolonged rest and extension in bed. The surgeon follows the pus forwards on either side of the spinal cord towards the body of the vertebra. Carious bone is scraped out, and the tubercular cavities rendered aseptic. If there is any tubercular thickening on the outer surface of the meninges, this is cut away. The sheath is kept intact wherever possible.

Laminectomy for Spinal Cord Tumour.—Laminectomy has been successfully employed for the removal of a tumour from the spinal cord, the presence of which was shown by pain and increasing signs of pressure, other causes being excluded. If the meninges have to be divided, they are afterwards sutured.

The special point after operation is to avoid decomposition of the cerebro-spinal fluid as it escapes. Abundant absorbent dressings and boric acid powder are frequently required. The spine is kept rigid, the urine, fæces, and skin of the back being very carefully looked after.

Bedsores.

Sores and sloughing of the skin are easily set up in weak patients from continuous pressure, especially over bony prominences, combined with the irritating effects of sweat and dirt adhering to the skin. They are most commonly seen on the back, owing to the continuous pressure on the bed in exhausted and helpless patients. Whilst the prevention of bedsores is one of the important duties of a nurse, yet the constant attention of the surgeon to the matter is also required. The advance in nursing has proved that a bedsore is not a necessary occurrence; the number of insane and paralytic patients so affected is now, where the nursing is good, very small.

The commonest site for bedsores is over the sacrum and the adjacent buttocks. Less common sites are: over the great trochanters, from lying on the side or from the pressure of splints; over the anterior superior iliac spines, the knees, or the chest, from lying on the face, or from the pressure of bandages or bedclothes; over the bony prominences of the elbow, knee, or ankle, from the pressure of side-splints; on the point of the heel, from resting on a hard splint; over the ischial tuberosities, from sitting up in bed; over the olecranon, from resting upon the elbows when the breathing is difficult; over a curvature of the spine, from the pressure of an apparatus; over the occipital prominence, from the combined effect of pressure on the pillow and parasitic eczema.

Bedsores are prevented by great cleanliness, and by varying the pressure. The skin is washed with hot water and soap, using a soft sponge or flannel; it is then swilled with clean water, and wiped quite dry with a soft hot towel. When quite clean and dry—not otherwise—fine zinc oxide and starch powder may be dusted on, or, if there is any irritation, lead and spirit lotion may be applied. The washing of the back is done at least once a day, or oftener—even every three hours—according to circumstances. The bed must be firm and elastic, without ridges or holes, the undersheet must be changed before it is saturated with sweat, and it and the draw-sheet renewed at once when soiled by urine, fæces, or discharge. Pressure is varied by changes of position, by suitable pads, air-cushions, and water-beds. Splints and plaster-cases are renewed frequently. The escape of urine and fæces should, if possible, be regulated so that the patient may be immediately cleaned. Regular catheterism and irrigation of the bladder, aperients, and rectal enemata for the removal of scybala, may afford improvement.

Incontinence of urine in the male may be met by putting the penis in the neck of a urine-bottle, a child's penis into a test-tube. The penis may be covered by a hood, from which a tube leads to a receptacle under the bed, or a suitable clamp may be put on the penis, to be released every four hours. For incontinence of urine in a woman, a self-retaining rubber catheter may be inserted, which conducts the urine into a receptacle, and a pad of wool is placed over the vulva, which is changed before it is soaked through.

If there is incontinence of fæces, the motions should be received on a pad, which is changed before the bed gets soiled.

The evidences of the formation of a bedsore are a dusky-red induration and pitting of the skin. If pressure with the finger obliterates the blush, and if the pitting quickly disappears on taking off the finger, congestion, and not thrombosis, has taken place, and the foregoing preventive measures should be actively carried out. When the patch tends more to a bluish-black colour, which does not disappear on finger-pressure, and a pit remains after relaxing the finger, if the epidermis separates, exposing papillæ of a greenish hue, an incision should be made through the sloughing skin, and small strips of iodoform gauze slipped beneath it. A collection of pus, septic absorption, and the further destruction of skin, are thus prevented.

As soon as the slough is outlined, it should be cut and scraped away, and the ulcer frequently dressed with antiseptic lotions, iodoform powder, and gauze, until covered with healthy granulations. If there is much destruction of skin, skin-grafting is done, the granulations are scraped off, the base treated freely with 5 per cent. carbolic acid, which is afterwards completely swilled away with simple water; pressure is applied until oozing has stopped, and then the whole is covered by epidermal grafts.

Neglected bedsores advance rapidly, and cause death by septic absorption, or by direct extension to the spinal cord.

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Baillière, Tindall and Cox, King William Street, Strand.